

JANUARY 1951



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Journal

AMERICAN
WATER WORKS
ASSOCIATION

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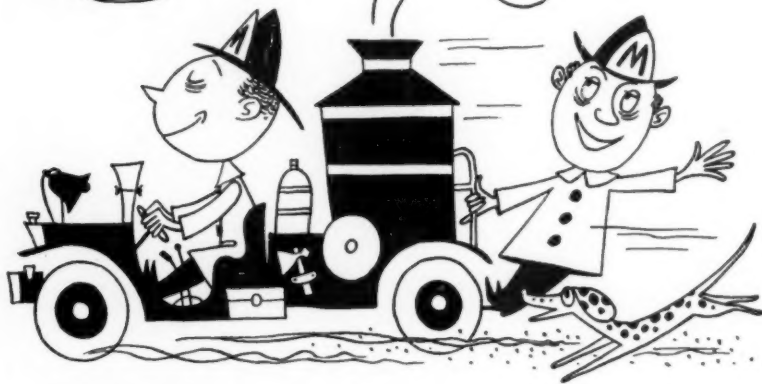


Ease of maintenance. The operating thread in this hydrant of rugged, simple construction is the only part to be lubricated—and then only on occasions of regular inspection and maintenance. The thread is protected from moisture from both the system and the elements.

MATHEWS HYDRANTS

Made by R. D. Wood Company

Public Ledger Building, Independence Square, Philadelphia 5, Pa.
Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds)
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MATHEWS MODERNIZED HYDRANTS OFFER THESE ADVANTAGES: All working parts contained in quickly replaceable barrel • Stuffing box cast integral with nozzle section—positively leakproof • Head turns 360° • Replaceable head • Nozzle sections easily changed • Nozzle levels raised or lowered without excavating • Protection case of "Sand-Spun" cast iron for extra strength, toughness, elasticity
A modern barrel makes an old Mathews good as new

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If your requirements call for transmission or distribution mains of 16" diameter or larger, Lock Joint Pipe Company can provide high quality concrete pressure pipe in all standard diameters and some intermediate sizes. Starting at a minimum of 16", Lock Joint Concrete Pressure Pipe is produced in 32 different diameters, and its four distinct types of structural design cover every working condition common to American water works practice.

Not only does Lock Joint Concrete Pressure Pipe qualify fully under A.W.W.A. specifications, but it alone embodies, in a conventionally designed pipe priced to meet competition, all the nine time-tested characteristics listed at right:

- PERMANENT HIGH CARRYING CAPACITY
- PROOF AGAINST TUBERCULATION, CORROSION AND ELECTROLYTIC DAMAGE
- IMMUNITY TO RUPTURE OR BLOW-OUT
- SAFETY UNDER EXTREME EXTERNAL LOADS
- EVERY JOINT FLEXIBLE AND WATERTIGHT
- EASILY TAPPED
- SPECIALS TO MEET INDIVIDUAL SPECIFICATIONS
- USEFUL LIFE CONSERVATIVELY ESTIMATED AT 100 YEARS
- MINIMUM MAINTENANCE AND REPAIR COSTS

Whether your proposed line is large or small it will pay you to use Lock Joint Concrete Pressure Pipe, the pipe of proven durability, economy and dependability.

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Reinforced Concrete
PRESSURE PIPE

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Made in United States of America

3 steps to more REVENUE

THRU PROPER
METER
TESTING

Every repaired domestic
meter should test at least

90% at $\frac{1}{4}$ gpm

For an accurate test
YOUR TEST

BENCH SHOULD
not FILL THIS
BOTTLE IN LESS
THAN 1 MINUTE



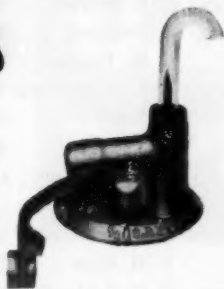
IF IT DOES — METERS WILL LOSE REVENUE

Yes, you should test $\frac{3}{8}$ " meters at $\frac{1}{4}$ gpm—because surveys show that 13% of all water passing these meters is used at that rate. A flow of $\frac{1}{4}$ gpm, unaccounted for, unpaid for, wastes over 10,000 gallons per month per meter! Check the low flow rate on your test bench by simply running the test water into a quart milk bottle. If the bottle fills in less than a minute, the rate is too high.

In that case . . . the Neptune Rate-of-Flow Indicator, a simple inexpensive device, can be easily attached to modernize your test bench. It enables you to establish test rates with accuracy . . . to stop loss of water revenue.

Your nearby Trident Representative is ready to arrange a demonstration.

For Accurate Testing
modernize
your test bench



with this Neptune
**RATE-OF-FLOW
INDICATOR**

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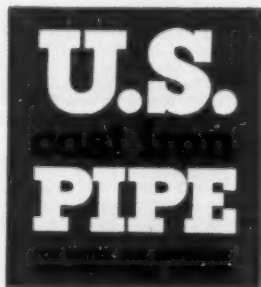


Boston's Faneuil Hall, popularly called "The Cradle of Liberty", as it looked 100 years ago-

Boston, Massachusetts, has cast iron water and gas mains in service that were installed more than a century ago. In those days, modern pavements were unknown; labor costs were low. Today, the expense of unnecessarily frequent repairs to underground mains, or untimely replacements, and consequent restoration of costly pavements, is a risk you cannot afford to gamble with.

Cast iron pipe has an established record of long life and low maintenance. It effectively resists corrosion and possesses the four strength factors so necessary to meet the stresses imposed by modern traffic and crowded underground construction. These are shock, crushing, bursting and beam strengths. No pipe deficient in any of these strength factors should ever be laid in paved streets of cities, towns and villages. United

States Pipe and Foundry Company,
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and Sales Offices Throughout the U. S. A.



NUMBER ONE OF A SERIES

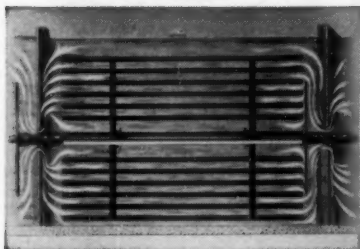
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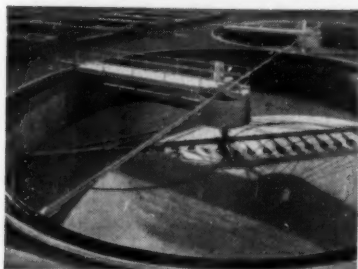
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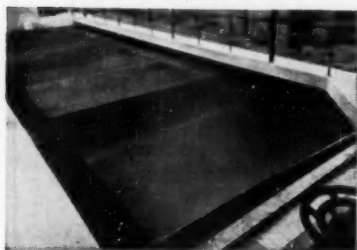
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Rex Floctrol



Rex Tow-Bro Sludge Remover



Rex Verti-Flo

and in plant after plant, the records show that Rex Water Treatment Equipment provides unequaled efficiency . . . sets the standards for economical, long-life operation.

Whether it's a large plant or small, a look at the figures will convince you that Rex Equipment is right for your operation . . . primary or complete treatment. Specially trained Rex Engineers will be happy to assist you with your individual problems. For all the facts, write for your copy of Bulletin No. 48-41. Chain Belt Company, 1609 West Bruce Street, Milwaukee 4, Wis.



Rex Conveyor Sludge Collectors



Rex Slo-Mixers and Flash Mixers



SANITATION EQUIPMENT

COMING MEETINGS

- January 16, 1951**—New York Section Luncheon Meeting at Park-Sheraton Hotel, New York. Secretary: R. K. Blanchard, Vice-Pres., Neptune Meter Co., 50 West 50th St., New York 20.
- February** **7-9**—Indiana Section at Lincoln Hotel, Indianapolis. Secretary: G. G. Fassnacht, 366 Good Ave., Indianapolis 19.
- 14**—New Jersey Section Winter Luncheon Meeting at Hotel Essex House, Newark. Secretary: C. B. Tygert, Box 178, Newark 1.
- March** **16**—New England Section at Hotel Statler, Boston, Mass. Secretary: G. G. Bogren, Weston & Sampson, 14 Beacon St., Boston 8.
- 28-30**—Illinois Section at La Salle Hotel, Chicago. Secretary: J. L. Hart, Asst. Western Sales Mgr., U.S. Pipe & Foundry Co., 122 S. Michigan Ave., Chicago 3.
- April** **5-6**—New York Section at Hotel Ten Eyck, Albany. Secretary: R. K. Blanchard, Vice-Pres., Neptune Meter Co., 50 W. 50 St., New York 20.
- 11-13**—Kansas Section at Lamer Hotel, Hays. Secretary: H. W. Badley, Neptune Meter Co., 640 Highland St., Salina.
- 19-20**—Nebraska Section at Cornhusker Hotel, Lincoln. Secretary: E. Bruce Meier, Dept. of Civ. Eng., University of Nebraska, Lincoln.
- 20-21**—Montana Section at Helena. Secretary: A. W. Clarkson, Asst. Director, Div. of San. Eng., State Board of Health, 1036 Eighth Ave., Helena.

A.W.W.A. 1951 ANNUAL CONFERENCE

Miami, Fla., April 29—May 4

Reservation forms will be mailed to all members, and all reservations will be cleared through the A.W.W.A. office. The hotels have agreed to accept no reservations for the 1951 Conference except as they are requested on the standard form provided by the A.W.W.A.

71st Annual Conference

- May** **17-19**—Pacific Northwest Section at Vancouver, B.C. Secretary: O. P. Newman, Secy., Boise Water Corp., Boise, Idaho.
- 21-23**—Canadian Section at Royal Alexandra Hotel, Winnipeg, Man. Secretary: A. E. Berry, Ontario Dept. of Health, Parliament Bldgs., Toronto 2, Ont.

In high-rate water treatment units

it's *performance* that counts!



Here's the kind of performance
you can expect from—
DORRCO HYDRO-TREATORS

PLANT	JUNCTION CITY, KANSAS	LOCKLAND, OHIO	APPLETON, WISCONSIN	A CANADIAN PAPER CO.	T.V.A., SHEFFIELD, ALABAMA
OPERATION	SOFTENING	SOFTENING	SOFT. COLOR & TURB. REM.	COLOR REM.	ALGAE & COLOR REM.
NO. AND SIZE OF UNITS	2-35' DIA.	1-31' DIA.	1-45' DIA.	2-80' DIA.	1-50' DIA.
CAP. PER UNIT, M.G.D.	1.5	1.0	3.1	10.0	3.0
GAL./SQ. FT./MIN.	1.08	.93	1.35	1.34	1.07
AVG. TURB. EFF., PPM	LESS THAN 0.2	5.0	2.4 to 4.7	3 to 5	4 to 7
SLUDGE-% SOLIDS	35 to 46.5	24.9 to 39.2	16.7	—	—

Here are the reasons for this performance . . .

Uniform Feed Distribution . . . feed is distributed within the sludge blanket by means of rotating arms which constantly agitate the blanket.

Concentration of Sludge Solids . . . sludge solids are collected and concentrated in a central thickening well and are positively removed to avoid the accumulation of a sludge blanket of excessive depth.

Positive Sludge Removal . . . sludge is removed from the entire tank floor positively and continuously by means of rakes attached to the rotating arms.

If you are investigating high-rate, up-flow type units, get *all* the facts before deciding. A Dorr engineer will gladly supply detailed figures and operating results . . . at no obligation.

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Journal

AMERICAN WATER WORKS ASSOCIATION

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Journal

AMERICAN WATER WORKS ASSOCIATION

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The Need for Water Works Reequipment

By W. Victor Weir

*A statement prepared by W. Victor Weir, Pres., A.W.W.A., and Pres.,
St. Louis County Water Co., St. Louis, Mo.*

TECHNOLOGICAL improvements in the water works field not only are contributing to the improvement of the quality of water delivered to consumers, but are also providing new equipment which allows more economical production and distribution. Improvements in methods and equipment are being made each year. Immense strides have been taken in the last twenty years, yet many American water works have not discarded old, inefficient equipment to reequip their plants with modern facilities.

American industry generally follows a rigorous reequipment policy. Only the concerns which quickly throw out inefficient machinery can survive in a freely competitive industry. There has been a willingness of American industry to "stick its neck out" to replace physically good, but obsolete, machinery with more efficient units. American industry, in that one respect, imitates the turtle, which makes progress only when its neck is out. In how

many water works plants are there progressive reequipment policies?

A publication (1) issued in 1948 by the Machinery and Allied Products Institute appraises an important reason why American competitive industry has outstripped British industry. Possibly some American water works could profit by seeing whether the following lessons learned from British industry might not apply, nearly word for word, to sizable parts of their plants:

So far as we may judge from the territory surveyed by [British] working parties and others, it is safe to say, with only slight risk of exaggeration, that Britain knew how to build great industries but never learned how to rebuild them. At their inception, they were the last word in modernity and efficiency, a model to the world. But they became decrepit with age. What happened was a failure of reequipment policy.

No live industry can keep abreast of technology without continuous renewal and transformation of its productive fa-

cilities. Existing equipment must be kept on the defensive, compelled always to justify its tenure against the challenge of currently available alternatives. If it fails to meet this challenge, it must be displaced, regardless of its age or condition—regardless, therefore, of whether it is physically “worn out.” A reequipment policy that fails to give full recognition to obsolescence is bound to lead to bad mechanization and inefficiency.

The contrast between original equipment policy and reequipment policy, so conspicuous in Britain, is by no means wholly lacking in the United States. It is, indeed, fairly common to find long-established enterprises [including some water works—*Author*] using facilities they would not dream of buying, even for a song, if they were going into the business in the first place. . . . If their present policy is correct, however, they should equip . . . by scavenging the mechanical graveyards for cadavers similar to the antiques they now employ.

The water works industry should follow the lead of American competitive business in adopting policies calling for the replacement of old equipment whenever its retention can no longer be justified economically, regardless of its physical condition. Water works management, public and private, must realize that operating as a monopoly does not relieve it of the responsibility of keeping plants equipped with the most economical and efficient equipment available.

In the last 20 years centrifugal pump efficiencies have materially improved. The same holds for boilers, turbines, internal-combustion engines and other plant items. Modern central stations can often deliver power at a lower cost than it can be produced in an isolated plant. Small, mass-produced diesel engines are now available with efficiencies

approximating those of the bulky, costly, older engines. New fuels, oil and natural gas, are available in many cities. Efficiency tests of present operating equipment, compared with improved efficiencies of available replacement equipment in an engineering economy study, will show whether an “old reliable” should be thrown out. More often than not, operating savings alone will justify a new unit. Reliability and lesser maintenance of such a new machine will usually be clear additional profit.

Typical Examples

A few examples of what might be done in typical water plants will suffice:

Centrifugal pumps illustrate most dramatically the fact that modern, properly selected equipment is the only kind the utility can afford to operate as firm capacity.

Two examples of replacement savings were reported in the October 1940 JOURNAL. A. M. Brenneke (2) related how Dennison, Tex., scrapped nineteen-year-old pumps and motors, the replacing units paying for themselves in two years. These pumps were paid for in a novel manner. Since power savings were estimated to be \$250 per month, the pump company took notes from the department payable in this amount and sold them to a Dennison bank for cash. The department paid for the pumps in two years without increasing its expenses, as the monthly payment for the pumps was no more than the decrease in power bills.

Also, George S. Rawlins (3) reported how Charlotte, N.C., had replaced one fourteen-year-old and two twenty-five-year-old centrifugal pumps with new units. Field tests showed that

efficiencies increased from 66, 56 and 56 per cent to 91, 89 and 85 per cent, respectively. The annual saving in power cost, \$21,951, was more than sufficient to finance the cost of the new pumps, which had twice the capacity of the old ones, plus the cost of 28,000 ft. of 30-in. transmission main.

The power bill for a 1-mgd. pump, operating continuously at a 200-ft. head, with an efficiency of 75 per cent and a power cost of 1.5¢ per kilowatt-hour, will be \$420 per month, while the cost of the pump end is approximately \$350. Thus, the power bill equals the pump cost in 25 days. If a typical pump had a water-end efficiency of 70 per cent, the power bill for a month's continuous operation would be \$450. If the efficiency of a new replacement unit is 79 per cent, the saving in power cost will be \$50 per month—\$600 per year—if a new unit is installed.

Considering compound interest at 6 per cent and a 20-year life, the cost of a new water end at \$350, plus \$150 for freight and installation, would be \$43.50 per year (capital recovery factor, $0.087 \times \$500$). Besides returning 6 per cent interest on the new investment and providing adequately for depreciation, replacement will produce an additional saving of more than 110 per cent of the pump cost each year.

Suppose that a similar pump, under similar head and power cost conditions, has been operating only a year or so. Because of an improper selection of operating head, the pump delivers at 70 per cent efficiency instead of at 79 per cent, which would be the efficiency if the pump closely fitted the actual head-capacity condition. Reequipment with a new impeller, at a total cost of not more than \$150, will restore the expected efficiency. Savings in power

would pay for the new impeller in less than three months. There would be a \$50 per month clear profit thereafter from a reequipment investment of only \$150.

Worn impeller or case rings may cause wastage as great as 15 per cent of the power bill. The cost of reequipping with new rings may be returned in a few weeks in power savings.

Steam turbines can drop in efficiency for more reasons than apply to centrifugal pumps. Although an old turbine may never reach modern efficiency standards, even if placed in perfect condition, a basically efficient unit may become uneconomical because certain moving or wearing parts need replacement, or because auxiliary equipment—for example, the condenser or vacuum pump—may need replacing.

Boiler efficiency is probably overlooked more often than the efficiencies of prime movers. With today's high fuel and labor costs, new boiler units should be considered. Also, the alternatives of different fuels, purchased power and diesel engines should be studied.

Inaccurate chemical feeders are often operated so that they deliver at least as much chemical as is always required, and, therefore, often more than necessary. The excess chemical fed is generally wasted. The saving in chemicals made by an accurate feeder will often pay for the new feeder in a very few months. Similar examples could cover purification equipment, structures, automotive equipment, meters, billing and commercial department equipment and so forth.

Relief of Overtaxed Facilities

The following of a wide-awake reequipment policy will often show that

the functioning of one unit of equipment may be improved by changing some other unit, process or practice. Increased water demand may be overtaxing a filter plant. Instead of installing more filters, it may be economical to provide equipment to allow better conditioning of the water prior to filtration. Plant capacity may be overtaxed during peak load periods. Elevated or ground level storage in the distribution system may be the answer rather than the installation of more plant capacity.

The source of supply, plant or distribution system may be overtaxed because the water utility is supplying water during peak periods at charges below the cost of such service. This usually pertains to industrial supply and to peak load customers using water for irrigation, swimming pools, ice plants and air conditioning. The imposition of properly designed water rates or reasonable regulatory control may cause such customers to get their supply elsewhere, if cheaper, or to adopt water conservation equipment, forestalling the need for uneconomical investments by the utility in plant extensions.

Water system facilities are being overtaxed in some communities where "selective" metering is practiced—that is, where only larger customers are metered. There is no penalty for the householder who wastes water. The penalty is placed on his neighbor who uses what he needs and no more. The inequity of flat-rate charges may not be serious from the utility viewpoint if total revenue is sufficient, but the matter of waste is, particularly where capacity is overtaxed. It is also of concern to those handling the community's sewage. Instead of spending more

money on wells, water plant, mains, sewers and disposal plant to reequip these facilities to meet growing community wastage, the installation of water meters is much more economical. City after city, large and small, has reported a 50 per cent drop in per capita use of water, another way of saying that the capacity of the system may be greatly increased at the very low cost of installing meters.

Although many water departments and companies have increased their rates, the average American now purchases his water supply with fewer minutes of daily labor than he ever had to expend before. Very few city-dwelling wage earners have to work more than four minutes a day to earn the water supplies for their families; two minutes of work a day will buy the water supply for most. This very cheapness of water is, in many communities, defeating the efforts of water works management to make the water supply better, more reliable and even cheaper. There must be sufficient revenue to provide, after all expenses are paid, the means to purchase and install the modern equipment now available.

Members of city councils, water boards, water commissions and boards of directors have the responsibility of seeing that their water works systems are just as efficient as the private businesses with which they are individually connected. They should insist that each water works have sufficient income, usually through realistically adjusted water rates, to allow the plant to be made economical and reliable. In many plants, improvements can be made which will return an annual profit of 20-200 per cent on the investment. It might be termed dereliction of duty if efforts were not made to obtain the

money necessary to allow such improvements.

Manpower and Material Economy

Should a reequipment policy be pushed at this time, when the nation is being asked to conserve materials and manpower? In the final analysis, a sound reequipment policy can result only in the conservation of materials and manpower. That is the only way the savings can be made which justify the investment in replacement equipment.

As an example, pumps which should be replaced are wasteful of power and power transmission facilities, wasteful of fuel, labor and everything else which goes into the cost of power. They are unnecessarily using up power or fuel which may be sorely needed for other purposes. There is practically no net loss of materials going into the new unit. The old unit is available for salvage and may actually contribute more metal than the new, more efficient unit requires.

Other inefficient machines in use in various water utility departments waste power, gasoline, fuel oil, coal, tires, chemicals and labor. Each of these items is generally in short supply in times of national emergency. The fact that a national emergency is at hand now, and may be more critical in the future, is a signal that water works reequipment should be accelerated rather than postponed.

The water works industry has not sponsored so much research as have

other industries of comparable standing. It is not, however, kept from receiving the advantages of research made by the businesses which supply water works equipment. When American industry spends \$750,000,000 annually on research, as it has been doing, it is not only putting American industry far ahead of that of other countries, and improving the domestic standard of living, but it is also producing improved machines and equipment for use in water works plants.

The businessmen on the city council, or water board, or commission or board of directors expect the water works management to keep good business control over the operations and plant of the utility. They will not think a replacement policy harsh when an engineering economy study indicates that a certain unit should be retired. It is a practice they insist upon in their own competitive businesses. There is no more reason for a sensible reequipment policy in a competitive business than there is for a realistic reequipment policy in each water utility operation.

References

1. Technological Stagnation in Great Britain. Machinery & Allied Products Inst., Chicago (1948), p. 63.
2. BRENNEKE, A. M. A Program of Equipment Replacement. Jour. A.W.W.A., 32:1689 (Oct. 1940).
3. RAWLINS, G. S. Discussion of A Program of Equipment Replacement (A. M. Brenneke). Jour. A.W.W.A., 32:1693 (Oct. 1940).

Construction Trends in the Water Works Field

By Vernon R. Kneer

A paper presented on Oct. 27, 1950, at the Iowa Section Meeting, Des Moines, Iowa, by Vernon R. Kneer, Engr., Alvord, Burdick & Howson, Chicago.

RISING costs—particularly, rising labor costs—today dictate most of the construction trends in the water works field. Material costs are definitely on the way up. On contracts which are being let now, many subcontractors and equipment manufacturers are refusing to bind themselves by prices or quotations without escalator clauses to protect them. With the national defense program taking 30 billion dollars a year, or 10 per cent of the national income, and with 3,000,000 workers, representing 5 per cent of the total labor force, taken from industry, price trends are bound to become inflationary. Factors such as the possibility of increased freight rates and the certainty of higher taxes in 1951 all indicate that costs will continue to go higher.

Labor costs are climbing faster than construction costs, and published wage rates do not tell the entire story. An increasing number of trades are demanding and getting special allowances and bonuses over their published rates.

A study of price trends following both the Civil War and World War I shows that rising costs were the rule for a period of thirteen years after the end of each of these wars. The trend since 1945 follows the same definite pattern, and it would seem, therefore, that all projects needed within the next

five years which are economically justified should proceed without further delay, as rapidly as materials become available.

Better standards of service and higher quality of product, along with soaring construction costs, are today definite trends in the water works field. Water works utilities must purchase their facilities with a dollar which is rapidly losing its integrity, a rubber dollar. Roughly speaking, the 1913 dollar was worth about 50¢ in 1939 and now has a value of less than 25¢.

Before discussing briefly some of the various other construction trends in the water works field, it might be well to get more familiar with the relationship between labor and construction costs for the past 37 years. The average hourly wage rates of all building trades stood at 600 in October 1950—six times what they were in 1913—while the *Engineering News-Record* construction costs index followed closely at 530. Construction costs, therefore, reflected 88 per cent of the wage increase. The index for common labor was 705. It is realized that there are limits to what index numbers can prove, but they do have their uses as general indicators of trends.

Stated simply, the cost of common labor is seven times as high as in 1913. It is this increase which has largely

dominated trends in all fields, particularly in construction. Practically all of the advances, improvements and design trends have been dictated by a real necessity to get around the increased cost of manpower with mechanization. The wider use of equipment and machinery has been, and is, "in the cards" because of labor's shortsighted policy of constantly seeking higher wages for less productivity. It has been good business to use machinery to replace many high-cost manual jobs. Labor union featherbedding has been in no small measure directly responsible for this trend from manpower to machine.

Certain items which reflect this drift toward mechanization to a greater or lesser degree and which will be discussed briefly are: excavation and foundations, concrete, building superstructures, pipe and pipe laying, elevated tanks, and well and intake construction.

Excavation and Foundations

Excavation offers perhaps the only department in construction where costs have not more or less closely followed labor rates. Unfortunately, excavation costs represent but a small portion of the total expense of most water works improvements. Generally speaking, there has been little or no increase in unit excavation costs for the past 50 years. This branch of construction serves as an excellent example of keeping costs down by cutting down man-hours. Like the automobile manufacturers, the makers of earth-moving equipment have been on their toes, with the result that this equipment has been one of the leading factors in construction development.

The author can remember one of his early assignments in 1926, where a

good-sized excavation job was done largely by team and scraper, and the surplus hauled by mule and wagon, at a unit cost of 50¢ per cubic yard. Labor, largely colored, was getting 35-40¢ per hour on this job. At Des Moines, about 20 years later, during the construction of the impounding reservoir, earth was excavated, moved and compacted, by scraper loaders, diesel trucks and tractor-driven sheepsfoot rollers, at an average cost of less than 40¢ a yard, with operators receiving about \$2.00 an hour. The clay core in the dam was placed using the most recent advances that had been made in the growing field of soil mechanics. By employing material with a moisture content near the optimum, high compaction was effected with sheepsfoot roller and rubber traction. A definite trend to rubber traction is evident in all excavation equipment.

Speed is another accomplishment in earth-moving operations. Forty years ago the placing of 30,000 cubic yards in an earth fill dam by team and scraper was considered quite a good summer's work. Now that amount of earth is moved in a day.

In foundation work, greater savings would result if obsolete building codes were revised. This is particularly true for pile foundations, where permissible working loads should be based on actual tests rather than abstract formulas.

In water works construction where wet excavation is common, well points, under certain soil conditions, are being more widely used to dewater areas for foundations and trenches.

Concrete and Concrete Construction

A number of trends have developed in concrete design and construction. Allowable unit stresses in both con-

crete and reinforcing steel have been increased. Twenty-five years ago it was the general practice to use stresses of 600 psi. for compression in concrete and 16,000 psi. tensile for steel. Today 1,000 is more generally used for concrete and 20,000 for steel. The Portland Cement Assn. recommends a further increase to 24,000 psi. for steel. Reinforcing steel has improved. Better deformation provides a better grip. Higher unit bond stresses are likely to follow.

Better batching control has resulted in more uniform concrete. Better control is, in general, more easily obtained at a central mixing plant than on the job site. The proportions of cement, aggregates and water are determined by developments based on the water-cement ratio. In placing concrete, vibrators and vibrating machines have become a must. Panel forms which can be reused many times are favored. Plywood with its many reuses is replacing costly form lumber. Portable sawmills are one of the first pieces of construction equipment moved on the average job today. In concrete reservoirs and water-containing structures, there is a definite tendency to get away from expansion joints by using temperature steel.

Building Superstructures

In building superstructures, greater use has been made of panel construction, precast concrete and light-weight aggregates for concrete and plaster. Precast concrete roof slabs, made with high-early-strength cement and drained of excess water by the vacuum process, have speeded construction on jobs where the time element is important.

Lighter-weight construction is a definite trend. The use of aluminum and

stainless steel is increasingly common. Today about 20 per cent of the aluminum production goes into building construction, compared with 4 per cent before World War II. At the Des Moines softening plant, the outside spandrels, the operating table grilles and the ornamental stair railings were aluminum.

Each of the individual filter units at the Des Moines plant can handle 6 mgd., based on a rate of 3 gpm. per square foot. Thirty years ago a filter of this capacity would have been unusual even in the larger plants. The construction economies resulting from building fewer and larger units have been clearly demonstrated.

A greater variety of structural-steel sections has been placed on the market in the past few decades. Consideration is being given to raising the allowable tensile stresses in structural members. Welding is being more generally used in the erection of structural steel.

Greater use is being made of glazed-tile walls for interiors in water works construction. In a water works, where cleanliness is of first importance, tile can be used for large areas which would be expensive to paint and difficult to keep clean. Glass block serves a useful purpose in filter building construction. The use of patented mixed mortars for tile, brick, block and stone is almost universal. Not long ago a device which was reported to lay 3,000 bricks a day attracted attention. Saws for cutting tile, brick, stone and concrete are now common on larger jobs.

At present obsolete building codes in many sections of the country restrict the use of new equipment and materials. It is encouraging to observe, however, that almost all of the larger

cities are currently reviewing and, in general, revising their codes on the basis of performance standards. Labor unions have been and will continue to be an obstacle to new developments in construction.

Pipe and Pipe Laying

There is a definite trend toward mechanization and away from manpower in trenching and in the installation of service connections. Drifter drills for boring services are used advantageously where conditions warrant. The early service connections were run with lead pipe. Galvanized iron and steel followed. Today copper is used almost universally.

In recent years more water utilities, especially the smaller ones, are having more of their main extensions, and even repairs and maintenance work, done by contract, and doing less with their own forces. This tendency, together with the fact that about 30 per cent of the new cast-iron pipe laid today has mechanical joints, indicates the drift away from manpower.

Only a few other developments need be mentioned. The economy of using concrete pressure pipe for transmission lines 16 in. and larger has been well demonstrated. Prestressing concrete steel cylinder pipe has resulted in further savings. The practice of laying cast-iron pipe with cement joints is becoming more widespread. Where lead joints are used, there is a tendency away from jute as a dam material and toward rubber and sterile materials. Greater care is taken in the sterilization of mains while they are being laid and before they are put into service. Losses in carrying capacities of cast-iron lines in areas troubled by tuberculation and incrustation are being cut

down with cement-lined pipe. Old cast-iron mains are being successfully lined in place. The time required to repair breaks in large cast-iron pipelines and to make connections has been shortened by cutting pipe, in place, with electric torches equipped with high-carbon-steel rods. Dry ice has been serving a useful purpose in blocking service connections.

Elevated Tanks

In the construction of elevated steel tanks, welding has replaced riveting entirely. Hollow tubular towers or legs for supporting the tanks have practically superseded the old structural-steel members. The upper portion of the tank is more largely utilized for water storage.

Intake and Well Construction

Intake construction has always been expensive and will continue to be. Any development which might reduce costs is welcome. Because of the difficulties and uncertainties in making pipe connections under water, the tendency will be to use joints where tightness can be guaranteed with fewer bolts and a minimum of diver's time. Blasting rock for intakes has been simplified by better drilling techniques and better explosives. Several years ago, on an intake job with which the author was connected, an underwater trench, 10-20 ft. deep, was dug through solid rock, without explosives. A dipper dredge operated by a skeleton crew ripped the material out of the lake bottom.

Underwater cutting and welding has been simplified by the air-oxygen process. Cutting now requires little special equipment and practically no special instructions. Anyone who can weld

above water will have little difficulty learning to weld under water. Rifles for installing anchor bolts and for bolting together steel plates both under and above water have been available for some time.

Excavation for supply wells has been simplified, where large boulders are absent, by hydraulic pumping and sluicing. Both strainer and casing of such wells are usually concrete lined, and gravel packing is employed.

Summary

Space permits listing only a few of these past developments and recent trends. In a period that started out with the horse and buggy and wound up with the jet plane, television and atomic energy, the water works industry

need offer no apologies. Water systems throughout the country today are efficiently serving 85,000,000 people with the most important commodity of all at a cost of about 5¢ a ton, with a total investment of six billion dollars. These water works, however, cannot continue to do their job properly without adequate revenues, particularly when rates are based on a dollar of rapidly diminishing value both here and abroad.

It should be emphasized that if one conclusion is to be drawn from the pattern of construction trends today, it is this: all water works improvements and enlargements which are economically justified and will be needed within the next five or six years should proceed without further delay.



The Philosophy of Supplementary Treatment of Public Water Supplies in the Interest of Group Health

By A. P. Black

A paper presented on May 24, 1950, at the Annual Conference, Philadelphia, by A. P. Black, Chairman, Dept. of Chemistry, Univ. of Florida, Gainesville, Fla.

ON May 29, 1949, the Board of Directors of the A.W.W.A. adopted and caused to be published (1) a statement of recommended policy and procedure with respect to the fluoridation of public water supplies. In so doing, it became the first national organization to take a definite stand on this somewhat controversial problem. The Association was led to take this action by the following considerations:

1. There is a constantly mounting body of evidence to indicate that the presence of 1.0–1.5 ppm. of fluoride ion occurring naturally in communal water supplies is associated with a 50–65 per cent reduction in the prevalence of dental caries.

2. This constitutes presumptive evidence that the addition of the fluoride ion to public water supplies in approximately the same concentration should produce essentially the same effect.

3. As all epidemiological evidence is presumptive, the case for the supplementation of public water supplies with fluoride is not weakened by the fact that the evidence which has accumulated thus far is presumptive. The addition of lime juice to the diet of the sailors in the English navy was begun about 1747, but it was not until 1932

that King and Waugh demonstrated that its ability to prevent the dreaded scurvy was due to the presence of Vitamin C. Countless other examples could be cited.

4. No evidence has thus far been advanced to indicate that the fluoride ion in such concentration produces any deleterious or toxic effects on the human organism.

5. The effect of added fluoride ion in substantially reducing the incidence of dental caries is capable of scientific demonstration, and several carefully conducted tests are now under way to that end. Several years must elapse, however, before definite conclusions can be reached.

6. Last, and perhaps most important from the standpoint of this discussion, the elements of the present situation pose an ethical question. It has been well stated by Enslow (2):

If the process proves worthy of adoption sometime hence, a community denied fluoridation during any period of "watchful waiting" will have lost the value of the treatment for such period. Neither is it pleasant to contemplate that such loss in tooth protection amongst the youngsters cannot be made up through subsequent water treatment.

Code of Practice

In the midst of this dilemma, it is natural to turn to the A.W.W.A. Code of Practice (3), to which every member of the Association subscribes. Of the ten principles set forth in that code, each of the first five has a direct or indirect bearing on the question:

1. To the best of my ability I shall conduct all operations under my control in such manner as will, as far as the means made available permit, provide adequate water service, *preserve the public health* and furnish protection to property.

Since it has often been stated that dental caries and the common cold are the two diseases which most often afflict mankind, it follows that anything which would tend to reduce the incidence of either would certainly be in the interest of public health.

2. I shall consider that in performing this service I am required *at all times to act within the bounds of local, state and national law and within the field of orderly procedure among free men.*

In this principle, the Association recognizes the sovereignty of the law at the local, state and national level. It also sets forth, somewhat more subtly, and by implication only, the important principle that decisions having to do with public health measures should be made by those who, by virtue of training and experience, are best qualified to make them.

3. I shall, therefore, extend my own fund of technical and professional information to the end that *the procedures which I advocate are based upon well grounded information.*

In this principle, the Association subscribes to the rigorous demands of

the scientific method. It points with justifiable pride to the fact that, throughout its 70 years of activity, the work of its numerous technical committees has been based upon the best scientific information available at the time.

4. In every legitimate manner, I shall encourage the construction of water works structures, *the use of materials*, as well as management practices and operating procedures, which are economically sound and *in the public interest.*

In this principle, the Association points out that, of the two yardsticks which shall control its policies and procedures, one shall be that they are in the public interest.

5. I shall at all times discourage exaggerated, unfair or untrue statements concerning any operation or material connected with public water supply. In conformance with this principle, I shall endeavor to assist my associates *as well as the public, in obtaining a correct understanding of water works operations and materials.*

In this principle, the Association recognizes its obligation to keep the consuming public constantly informed on all water supply matters which in any way affect its health or welfare.

The directors of the Association, motivated by these principles and acting for the entire membership, have said, very simply and in summary, that (1):

In communities where a strong public demand has developed and the procedure has the full approval of the local medical and dental societies, the local and state health authorities, and others responsible for the communal health, water departments or companies may properly participate in a program of fluoridation of public water supplies.

But, in so doing, the directors realized that this statement represents only a tentative approach to an extremely difficult problem—that the issue is not closed, but only joined. It is the obligation of members of the water works profession to try as best they can to think through the basic philosophical and ethical issues which are involved. With due humility, one may apply the lines of Jane Taylor:

Though man a thinking being is defined,
Few use the grand prerogative of mind;
How few think justly of the thinking few,
How many never think who think they do.

Basic Issues

In a democratic society composed of free men, three questions arise regarding this problem: [1] Has the procedure under discussion *value* for society in the protection of public health? [2] If it can be shown that it has value, does the utility have the *right* to employ it in the treatment of public water supplies? [3] If the right to employ it exists, is there an *obligation* on the part of the profession to do so? Thus, it is necessary to define and distinguish between the terms "value," "right" and "obligation."

It is not easy to define the term "value," although society is pretty well agreed on certain common principles. For example, of two values the greater should be selected. Productive values are more desirable than nonproductive values. Permanent values are more important than temporary values. Authors in the field of ethics are not all agreed on the definition of a value. Some maintain that values are objective and that the term "value" may be defined as a quality in objects or situations which calls for their appreci-

ation or preference. On the other hand, there are those who maintain that values are subjective and that they may vary from person to person and from age to age. From this point of view, value may be defined as a measure of human desire, and, unless one wishes or desires a certain object or condition, that object or condition has no value to the individual involved. A definition which to a considerable extent harmonizes both views is that of Titus (4): "A value is a relationship between a person and an environmental situation which evokes an appreciative response."

Assuming that the term "appreciative" is used in its broad sense to include, among other connotations, a benefit to the individual, this definition fits the present situation. Paraphrasing it, one may say: "Any method of water treatment has value provided it results in a real and substantial benefit to the consumer."

A "right" has been defined (4) as "a claim to a condition which the individual needs in order to live at his best." Taking this view, it may be concluded that individuals have a right to demand those things the absence of which will impoverish them and the presence of which will enrich them, provided it is within the means of society to supply such things. Rights are relative as to both time and place. They change and vary with varying social conditions. They are not created by law; law merely recognizes and protects them.

As Titus (4) so aptly states:

Rights are thus based definitely upon values. From the recognition of a value should follow the recognition of the right to share in that value so far as the means are available. We have this principle clearly illustrated in the case of educa-

tion. A century ago a free education was not claimed as a right. The recognition of the value of education, however, led people to see that if it was valuable, then every child had a right to it. In other words, *the value itself created the right. Today we are interested in knowing if there are other values where the corresponding right has not yet been recognized or accepted by society. To say that life is a value or that a person has a right to live is to admit that he has a right to those things which he needs in order to live.*

The history of the world is a history of men who have fought and died for the preservation of certain human rights and a history of governments formed by men in order to protect and preserve them. The representatives of the thirteen original states who signed the Declaration of Independence in 1776 based their claim to independence on "certain inalienable rights," among which were "life, liberty and the pursuit of happiness." These three basic rights have been expanded by a developing social order to include such rights as the right to be well born, the right to freedom, the right to education, the right to work, the right to security, the right to health and many others. Varying political philosophies reflect different beliefs about how best to preserve and exercise these human rights so as to achieve the greatest good for the greatest number. Because in any list of human rights the right to health stands high, one may conclude that, if it can be shown that the addition of fluoride to a public water supply has value for the individual and for society in the promotion of public health, then society has the right to expect that it will be done.

The question of "obligation" is the heart of the problem. Titus (4) has

clearly stated the relationship between values, rights and obligations:

The recognition of a value implies an obligation to seek it. The field or area of obligations is thus coextensive with the realm of values, and rights and obligations are correlative. When new values and new rights come into being, they bring with them corresponding obligations. *A list of obligations or duties would be merely a list of rights in another form.* For example, if we have the right to life, liberty, and the pursuit of happiness, then we have the corresponding duty to respect the lives of others, to refrain from restricting their liberty, and to desist from placing obstacles in the way of their attainment of happiness. If there is the right to work and to receive a living wage, men have the responsibility of working and of giving a fair day's work for that living wage. The right to security implies the duty of assisting in the defense of the group. *The right to be well born implies corresponding obligations on the part of parents and of society toward future generations.*

If it is assumed, therefore, that the right to be well born and the right to health are human rights, it follows that there is an *obligation* to do the things that contribute toward those ends, if they are reasonable and practical.

The author has referred previously to the A.W.W.A. Code of Practice. Since 1890 more than 300 business and professional groups in this country have adopted codes of ethics or of practice. This is an outgrowth of the fundamental change which has taken place in the nature of society. There was a time when every man was his own carpenter, his own tailor, his own blacksmith, his own doctor. But a form of society has gradually developed in which the division of labor is the rule and most of the work is done by

specialists. This system creates more goods and services and more leisure for the individual. Along with it has come the growth of the professions, and the beliefs of individuals about ethical and moral problems have been merged into professional codes. With respect to such codes, two facts are worthy of special mention. First, almost without exception, they are based on the service motive. The profit motive, although important and necessary, is made secondary to "service above self." Second, and even more important, professional codes of ethics or of practice serve to prevent control or interference by the government or by society through some of its agencies. Such codes safeguard the right of that professional group most qualified from the standpoint of training and experience to make decisions on those matters which affect the welfare of society as a whole.

Conclusion

An attempt has been made to prove, from purely ethical considerations, that society has the right to expect that those things be done which contribute to the public welfare, provided they

are reasonable and practical. More important, however, it has been shown that, in a society such as America's, decisions on matters of major policy which affect the public welfare should be made by those professions or groups most qualified from the standpoint of training and experience to make them. In full realization of that principle, the A.W.W.A., speaking for the water works industry, has said, in effect, to the medical and dental professions: "If, in the light of all available evidence, you believe that the fluoridation of public water supplies is in the interest of group health, the water works industry stands ready, as it always has and always will, to participate with you in its practical realization."

References

1. The Fluoridation of Public Water Supplies. Statement of Recommended Policy and Procedure. Jour. A.W.W.A., 41:575 (July 1949).
2. ENSLOW, L. H. What About Fluoridation? Wtr. & Sew. Wks., 96:160 (April 1949).
3. Code of Practice. American Water Works Association, New York.
4. TITUS, HAROLD M. *Ethics for Today*. American Book Co., New York (2nd ed., 1947).

Discussion

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Most individuals in the majority of communities are affected by dental caries, which makes this one of the largest public health problems facing the nation. There exists an enormous amount of untreated dental defects which are largely the direct or indirect result of dental decay. According to a recent estimate, it would take 800,-

000,000 dentist-hours to catch up with this backlog, at a cost of four billion dollars, assuming an extremely low fee of \$5.00 an hour. These data demonstrate the importance of large-scale control of dental decay, particularly by a technique which is independent of the individual. A procedure of this type is the only satisfactory solution to the problem.

The artificial fluoridation of communal water supplies would be an ideal

technique if its value were proved and if it were not contra-indicated by damage to the teeth, system or industrial use of water. But these two conditions must be met.

Professionals and specialists have the duty of insisting upon a scientific demonstration of a high probability that a proposed method will be useful and safe, before it is recommended for general adoption. The maintenance of this attitude is of paramount importance.

The ease with which a communal water supply can be made a vehicle for the administration of all sorts of chemicals to the consumers holds out great promise, but it also invites trouble. Public health workers and water works engineers and administrators have a grave responsibility, which extends far beyond any good or evil that may come from fluoridation of the water supply—namely, the responsibility of acting only on adequate and convincing evidence. Any present judgment of the value and safety of this method is tentative. Therefore, to advocate it, except as an experiment, is premature and economically a gamble.

Whether the expenditure of public funds for the experimental fluoridation of a communal water supply, or for any other form of treatment for this or a similar purpose, is justifiable, depends on the nature of the experi-

ment. The experiment should be genuine, and not one in name only. In designing such an experiment, a careful and competent analysis of those now in progress should first be made, in order to see how they might be improved or extended. There seems to be no virtue in merely repeating one of the experiments already under way. The money needed for such a repetition might be better spent for some quite different purpose.

Before adopting a new experimental attack on the problem of artificial fluoridation of communal water supplies, this attack should be carefully planned, giving consideration to the questions which the experiment is desired to answer, the kind of evidence which will be acceptable, the manner of obtaining that evidence, the availability of competent personnel (including analysts of the data to be collected), the cost of the experiment and, finally, the possibility that the money, time and energy required might be more profitably employed elsewhere.

The attitude expressed in this paper may, perhaps, not be popular. The writer is not, however, asking for a long postponement of a decision on this problem. Definitive answers can be expected within a year or less. Consequently, the writer feels justified in advocating a waiting policy at this time.

The Advancement of Fluoridation

By H. Trendley Dean

A paper presented on May 24, 1950, at the Annual Conference, Philadelphia, by H. Trendley Dean, Dental Director, U.S. Public Health Service, and Director, National Institute of Dental Research, National Institutes of Health, Bethesda, Md.

AT the 1943 A.W.W.A. Conference the author (1) presented the basic epidemiological data and the laboratory findings upon which the fluorine-dental caries theory rested. Very briefly, the data showed that groups of children 12-14 years old who continuously used, since birth, a domestic water containing about 1 ppm. of fluoride ion experienced only one-third as much dental caries as comparable groups of children using a fluoride-free water.

At about the same time Arnold (2) compared the dental caries picture for the children of Aurora, Ill., where the water contains 1.2 ppm. of fluoride ion, with that for children living in three communities using fluoride-free Lake Michigan water (Evanston, Oak Park and Waukegan, Ill.). He found that, in Aurora: [1] there were six times as many children showing no dental caries experience (caries free); [2] there was about a 60 per cent lower dental caries experience rate; [3] there was almost a 75 per cent decrease in the first permanent-molar loss; and [4] there was approximately 95 per cent less caries on the proximal surfaces of the four upper incisors. Arnold concluded that the addition of small amounts of fluoride (about 1 ppm.) to fluoride-free public water supplies for the purpose

of partially controlling dental caries is strongly suggested on the basis of epidemiological and experimental evidence.

At the 1943 A.W.W.A. symposium, Ast (3) presented a detailed program for testing the fluorine-dental caries hypothesis by treating a public water supply under controlled conditions and concluded that if "this study proves to be practicable and effective, dentistry and public health may achieve a victory comparable with the control of many infectious diseases by immunization today."

Another participant in that symposium, Wolman (4), outlined water works history through the use of alum and chlorine up to the production of "tailormade" water supplies to meet consumer demand, both domestic and industrial. The evidence presented in 1943 posed an entirely new question, that of using a water supply "as a carrier for elements or complexes which would improve or raise the general level of the public health of the community." In closing, Wolman rightfully stated that 1943 was "not the day on which to press the water works operator to an acceptance of this proposal." It was, however, he added, "the day to press him toward an understanding of the reasons underlying the suggestion and to insist that in the

intervening three, four and five years it must be taken to heart as a new proposal, perhaps as a new opportunity for service."

During this seven years since the Cleveland meeting much additional basic work, epidemiological and laboratory, has become available. Toxicity studies recently summarized by Cox and Hodge (5) justify the conclusion that chronic, crippling fluorosis will never appear as a result of dental uses of fluorides and that, when the addition of fluoride ion is limited to about 1 ppm., mottled enamel, the most delicate sign of fluoride toxicity, will be found only in a very few individuals, and then in very mild form. No unaesthetic marring of the teeth should occur.

With the resumption of research activities in Western Europe since 1945, studies on various aspects of the fluorine-dental health relationship were begun and the literature is now being enriched by reports of investigations from that quarter.

In the United States, three well controlled studies are being conducted, at Grand Rapids, Mich.; Newburgh, N.Y.; and Evanston, Ill. A score of other cities are adding fluorides to the public water supply for the purpose of bettering dental health. All preliminary reports indicate a trend toward beneficial effects. At Grand Rapids and Newburgh, fluoridation has been going on since 1945, and within the next year or two these trends should develop definite patterns.*

The full impact of this preventive measure cannot, of course, be foretold directly or indirectly at present. When

one realizes that caries is responsible for roughly one-half of the dental service needs in this country and that the American people are paying close to a billion dollars a year for professional dental services, the effect in another generation may be as revolutionary as the control of communicable diseases a generation or more ago or as the present control of venereal diseases with antibiotics (8).

Further Studies

Obviously there must be continuing and expanded work in studying the relation of fluorine to dental health. Two studies of practical importance at the moment are cited merely as examples:

Climatological influence on optimal fluoride level (concentration). In 1949 the A.W.W.A. statement on fluoridation policy (9) noted: "It is quite possible that more than 1 ppm. [of fluoride ion] might be required in areas having a low mean annual temperature, such as the Dakotas, while 0.5-0.6 ppm. might suffice where climatological conditions are reversed, as in the deep South or the Southwest."

In December 1946 the author examined 110 twelve-, thirteen- and fourteen-year-old children, continuous residents of Moultrie, Ga., where the public water supply contains 0.7 ppm. fluoride, and 100 children of the same age at Brunswick, Ga., where the supply contains 0.5 ppm. The mean annual temperature in each city is about 68°F. The incidence of dental fluorosis, practically all of the mildest type, was 12.6 and 9 per cent, respectively. Under the climatological conditions prevailing in the Chicago area, with a mean annual temperature of about 49°F., such incidences would normally

* Since this paper was written, additional evidence of the effectiveness of this procedure has become available (6, 7).—Author.

be associated with a domestic water containing approximately 1 ppm. In areas where climatological factors influence the amount of water consumed (and, hence, the intake of fluoride), some modification in the 1-ppm. optimal level will probably be necessary. For practical public health purposes, therefore, it might be well to resort to the biological test for the optimal level—that is, a concentration of fluoride ion incapable of producing a “community index of fluorosis of ‘border line’” magnitude (greater than 0.4) (10, 11).

Use of cheaper fluoride compounds. A field worthy of considerable study is the comparative physiological effectiveness and cost of various fluoride compounds. A study recently completed by McClure (12), entitled “The Availability of Fluorine in Sodium Fluoride vs. Sodium Fluosilicate,” is a matter of much interest to all concerned with the problem of fluoridation of water supplies. McClure states that “with sodium fluosilicate currently selling at about half the price of sodium fluoride, the cost of fluoridation of 1 mil.gal. of water at an optimum level of 1.0 ppm. fluorine is approximately \$2.15 using sodium fluoride and \$0.76 for an equivalent quantity of sodium fluosilicate.”

The conclusions stated in McClure's paper are:

1. A comparison was made of the effect of fluorine ingested in rats' drinking water in the form of sodium fluoride vs. sodium fluosilicate, the quantity of fluorine equaling 5, 10, 15, 25 and 50 ppm.

2. No differences were observed as regards the quantity of fluorine deposited in the incisor and molar teeth, mandibles and femurs, nor in the percent of the ingested fluorine which was retained in the rat's body. There was no difference in the ash, calcium and phosphorus content of the

incisor teeth, molar teeth, mandibles and femurs which could be related to the kind of fluoride ingested.

3. There were no differences in the appearance of the characteristic striations on the rats' incisor teeth which could be attributed to the sodium fluoride vs. sodium fluosilicate.

4. The presence of 15 ppm. of silicon as sodium silicate along with 25 ppm. of fluorine as sodium fluoride did not affect the amount of fluorine deposited in the rat's body.

5. The rate of growth was normal in all groups of rats.

Water Supply as Control Medium

The role of drinking water as an indispensable requirement for animal life is properly emphasized by the fact that animals can live longer without food than they can without water. Under conditions of communal living, natural drinking water is universally provided as a community service. The city dweller to a large degree has lost the sense of dependence on a water supply which is inborn in the rural resident.

It used to be said that the people of a community reflected the composition of their native soil because of the obvious influence of the soil factors on the composition and supply of food-stuffs. With present-day methods of production and distribution, this generality no longer holds true in the United States, except in relatively isolated areas.

Drinking water, however, remains a universal article of diet. No other dietary constituent is so nearly similar for every man, woman and child in a community with a public water supply. As a practical vehicle for administering some substance to the entire population of an area, it is unequalled.

In most respects, an entirely new concept is embodied in the addition of something to the supply which is intended to have an added beneficial action over and above the usual function of the drinking water. Previous treatments, while they may have added substances to the water supply, were intended to remove or neutralize objectionable features. But when a factor is added which will increase resistance to a disease among the whole population, the philosophical implications are far reaching.

The maintenance of a good water supply, free at all times from contamination and safe for human consumption, is, in every conceivable respect, in the interest of group health. The continued maintenance of a common water supply free of health hazards has been and always will be a major health problem. Now a corollary to this long-held axiom is being considered. When advancing scientific knowledge clearly points out certain beneficial qualities which may be added to water during the treatment process, does this not constitute a step forward in public health and water works operation?

Today, more than ever before, man does not "let nature alone"; he strives to improve on nature, to duplicate or take advantage of it to serve his own well being. And, in the interest of communal or group health, there has arisen a philosophy, or possibility, of improving group health by the supplementary treatment of public water supplies. The beneficial qualities of a community drinking water can be determined and may be controlled, therefore, by man himself, in the interest of all men. Men, women and children of a community may become healthier individuals because of a controlled beneficial quality of their water supply.

This philosophy is now being assessed as it bears on dental health—that is, by the supplementary addition of fluoride to a communal water in order to curtail sharply one of man's most prevalent diseases, dental decay.

With its long experience in the control of enteric diseases, its clear understanding of epidemiological data, its mathematical insight into the influence of this proposal on a major group disease, the water works profession quickly realized the public health responsibility inherent in the fluorine-dental caries relationship. How wholeheartedly the profession entered into and accepted this new philosophy in water works practice is attested by the A.W.W.A. statement of recommended policy and procedure regarding the fluoridation of public supplies (9).

Conclusion

It might be well to refer briefly to one other feature of the fluorine-dental caries investigation. In modern science, there is increasing emphasis upon the integration of all disciplines having a bearing upon the subject of inquiry. The cross fertilization of ideas by scientists trained in different fields tends to enhance and expand the field of investigation.

The study of the relation of fluorine to dental health provides an unusually illustrative example. Starting as an epidemiological inquiry of a dental disease, it has expanded into the field of epidemiology, water chemistry, biochemistry, pharmacology, physiology, histology, biometry, bacteriology, dentistry, medicine, public health, sanitary engineering and water works operation; and, to a lesser extent, geology, climatology, veterinary medicine, physical chemistry and biophysics (radio-

active isotopes, electron microscopy and electron diffraction).

In this 20-year study each researcher has contributed to a specific facet of the problem and each has stimulated others in related fields. Numerous times findings long buried in the literature and apparently unrelated to oral disease were found on close study, or synthetization with other work, to bear an important relationship to the study at hand.

A recent World Health Organization newsletter (13) outlined the giant strides during the past 50 years in medicine and public health. Many diseases today are mere wraiths of their devastating former selves at the turn of the century. During this period some diseases, such as dental disease, the common cold and poliomyelitis, have successfully withstood attempts to control them. The rapid advance in research in medical science did not materially influence the prevalence of these diseases in the general population.

The next generation should see dental caries prevalence sharply reduced. In all probability, it will mark an era in which the water works profession will be instrumental in helping to bring dental caries under a large measure of control with the same quiet dispatch and efficiency that has previously characterized the profession's contributions to the control of the typhoid groups, cholera and dysentery. The powerful stimulus of this new control measure and the novel philosophy inherent in it should deeply affect public health thought and action.

References

1. DEAN, H. T. Domestic Water and Dental Caries. *Jour. A.W.W.A.*, **35**:1161 (Sept. 1943).
2. ARNOLD, F. A., JR. Role of Fluorides in Preventive Dentistry. *J. Am. Dental Assn.*, **30**:499 (April 1943).
3. AST, D. B. A Program of Treatment of Public Water Supply to Correct Fluoride Deficiency. *Jour. A.W.W.A.*, **35**:1191 (Sept. 1943).
4. WOLMAN, ABEL. What Are the Responsibilities of Public Water Supply Officials in the Correction of Dental Deficiencies? *Jour. A.W.W.A.*, **35**:1198 (Sept. 1943).
5. COX, G. J. & HODGE, H. C. The Toxicity of Fluorides in Relation to Their Use in Dentistry. *J. Am. Dental Assn.*, **40**:440 (April 1950).
6. DEAN, H. T. ET AL. Studies on Mass Control of Dental Caries Through Fluoridation of the Public Water Supply. *Pub. Health Repts.*, **65**:1403 (Oct. 27, 1950).
7. AST, D. B. Newburgh-Kingston Water Fluoridation Study. *Paper presented at Section on Research, Am. Dental Assn. Convention, Atlantic City, N.J., Nov. 1, 1950.*
8. STOKES, J. H. The Practitioner and the Antibiotic Age of Venereal Disease Control. *J. Venereal Dis. Inform.*, **31**:1 (Jan. 1950).
9. AMERICAN WATER WORKS ASSN. The Fluoridation of Public Water Supplies—Statement of Recommended Policy and Procedure. *Jour. A.W.W.A.*, **41**:575 (July 1949).
10. DEAN, H. T. "The Investigation of Physiological Effects by the Epidemiological Method," in *Fluorine and Dental Health*. Pub. No. 19, Am. Assn. Adv. Sci. (F. I. Moulton, Ed.). Science Press, Lancaster, Pa. (1942), p. 23.
11. ———. "Fluorine: Waterborne Fluorides and Dental Health," in *Dentistry in Public Health* (W. J. Pelton & J. M. Wisan, Eds.). W. B. Saunders Co., Philadelphia (1949).
12. McCLURE, F. J. The Availability of Fluorine in Sodium Fluoride vs. Sodium Fluosilicate. *Pub. Health Repts.*, **65**:1175 (Sept. 15, 1950).
13. ANON. Fifty Years of Medicine and Public Health. WHO Newsletter No. 13 (Jan. 1950).

Discussion

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The New York State Dept. of Health, in cooperation with local medical and dental societies and officials of the cities of Newburgh and Kingston, N.Y., has been conducting an investigation of the effect of 1.1 ppm. fluoride ion upon the incidence of dental caries in the permanent teeth of all Newburgh school children aged six to twelve. The incidence of caries among a similar group of children in Kingston, where the water supply contains little or no fluorine, has been used for comparison purposes.

The dental studies were inaugurated in the fall of 1944, and sodium fluoride has been added to the Newburgh supply since May 2, 1945. The powder has been added to the filtered water through the use of a small-capacity dry-feed unit mounted on scales. No difficulties have been encountered in transferring the powder from barrels to the hopper of the unit by means of a small, covered container which fits snugly to the top of the hopper and has a false bottom so that the material can be dumped into the hopper without the production of dust. The indications are, however, that the handling of larger quantities of the powdered material would justify the use of pneumatic equipment and air filters so that barrels of the material could be dumped into hoppers without dust reaching the operator.

Daily laboratory control by a graduate chemist is maintained, and samples are collected at the filtration plant and at representative points on the

distribution system for control purposes. Additional samples are submitted periodically to the laboratory of the New York State Dept. of Health.

A preliminary report on the dental and medical studies at Newburgh was published (1, 2) in June 1950. In general, the first three years of the study reveal a significant reduction in the incidence of dental caries at Newburgh, amounting to approximately one-half the reduction that would be anticipated were the treatment process as effective as when about 1 ppm. fluoride is present in natural waters. No harmful effects have been noted as a result of this water treatment process. The study is to be continued ten to twelve years to permit definite conclusions to be reached.

Health Department Policy

Heretofore the New York State Dept. of Health has followed a policy of considering the Newburgh study as a research project and has not recommended that public water supplies be treated with a fluoride compound pending the collection of significant information, unless similar research investigations were involved. The preliminary favorable results secured at Newburgh and elsewhere in the country have led the department to modify its policy, as indicated by the following statement, which has been approved by Herman E. Hilleboe, New York State Commissioner of Health:

In 1944 the New York State Dept. of Health initiated a study of the prophylactic value of fluorine ingested from an artificially treated communal water supply. Sodium fluoride has been added to the Newburgh water supply; Kingston has served as a control area. Careful

dental examinations have been performed periodically in both cities, together with other clinical and radiographic studies. A preliminary report giving the results of the first three years of the study reveals a reduction of approximately 30 per cent in new dental caries in the permanent teeth of six-to-twelve-year-old children in Newburgh, as compared with Kingston.

While the evidence to date is very encouraging, it is necessary to continue the study for the ten-year period, as originally planned, in order to obtain further data regarding the value of this technique and to be certain of its safety. To date there is no evidence of any harmful effects resulting from the use of water containing the small amount of fluoride used for this prophylactic service.

If communities, after consultation with their local medical and dental societies,

wish to establish this procedure, and where the communal water supply will lend itself to fluoridation and is under the direct supervision of a qualified engineer, the New York State Dept. of Health will make available its consultant staff in helping to plan the program and establish standards and procedures.

References

1. AST, D. B.; FINN, S. B. & McCAFFREY, ISABEL. The Newburgh-Kingston Caries Fluorine Study. I. Dental Findings After Three Years of Water Fluoridation. *J. Am. Pub. Health Assn.*, **40**:716 (June 1950).
2. SCHLESINGER, E. R.; OVERTON, D. E. & CHASE, H. C. Newburgh-Kingston Caries-Fluorine Study. II. Pediatric Aspects—Preliminary Report. *J. Am. Pub. Health Assn.*, **40**:725 (June 1950).



National Water Policy

Engineers Joint Council Committee Report

Excerpts from a statement (dated June 1950) on "Domestic and Industrial Aspects of National Water Resources Policy," prepared by Task Force No. 1 of Engineers Joint Council (Abel Wolman, Coordinator) for the President's Water Resources Policy Commission.

Introduction

TASK Force No. 1 submits herewith its report on "Domestic and Industrial Water Supply and Pollution," first summarizing its principal conclusions as follows:

1. The use of water resources for domestic and industrial purposes is believed to be the highest and best use. Without adequate water supply properly safeguarded against pollution, urban life cannot exist.

2. The use of water resources for domestic and industrial purposes is also the only universally distributed use. In this respect it is unlike irrigation or hydroelectric or flood detention, which are limited in area of development.

3. Although nationwide in development, domestic and industrial water supply present essentially local community problems. Of the 13,000 public water supply systems serving 85,000,000 people in the United States with approximately 15 bil.gal. of water per day, nearly all are intrastate. Only a few have interstate problems and a very limited number are concerned with more than two states.

4. Urban or private industrial water supplies should accordingly be built and paid for by those using the service.

The cost of water from public supplies, which is usually less than 2¢ per capita per day, is within the economic reach of all.

5. Since the domestic and industrial water supplies are of such prime importance, it necessarily follows that pollution of water resources must be so controlled as to make it practicable to provide a water of satisfactory quality as well as adequate in quantity.

6. Pollution of water should be regulated at the lowest governmental level adequate for the particular situation. Some will be wholly local, some at state level and some at state compact level. Federal jurisdiction and participation should be limited to the administration of existing laws; to research, investigation and guidance upon which sound state laws and local regulations may be based, with as much uniformity as is consistent under the variable conditions encountered.

7. On dual or multipurpose projects involving public water supply, the local community should pay its fair proportion of the cost, and the project [should] only then be carried forward if the remaining part of the cost to be provided from federal funds has a proper cost-benefit ratio.

Domestic and Industrial Aspects

The use of the nation's resources for public water supply constitutes the highest and best use. Such use must have first priority in the consideration of water resources development. . . .

Although comparatively small in amount, as compared to the total water resources, public water supplies are the most basic requirement for urban development. Urban life cannot exist except where adequate water resources of satisfactory quality are available for domestic and municipal purposes. Public water supply is the most universal of all uses of the national water resources—it affects every state and most cities and villages. Approximately two-thirds of the United States population now enjoys and is dependent upon public water supplies.

Since a large proportion of the water supply requirements for domestic and municipal purposes is derived from surface sources and requires purification to make it of acceptable sanitary quality, it necessarily follows that pollution of [a stream] from which water supplies are to be taken must be controlled within limits compatible with its purification for domestic use.

Likewise, over considerable areas where, through the development of natural resources, brines and acid wastes are a by-product, their disposal must be such as to permit the use of the water where necessary for its highest use, namely, that for domestic and municipal purposes.

Public water supplies are essentially local community problems. Only in a comparatively few cases are they statewide problems and in still fewer cases are questions of interstate policies involved. It is believed that, since the problems are essentially local, public

water supplies should be developed, regulated and paid for by those using the services.

There would appear to be no valid reason for the federal government to develop water resources for public and municipal purposes at any place in the country. Water from public supplies is relatively so cheap, usually costing at the consumer's faucet less than 5¢ per ton or less than 2¢ per capita per day, that practically any community can have and finance a public water supply if it has the will to do so. It is believed that over 50 per cent of the residential water takers in the United States pay less than 1¢ per capita per day for their water.

But few public water supplies pose interstate problems. It is believed that those few where more than one state is involved introduce no problems directly at the federal level but can best be solved by a compact of the states whose interests are affected, with federal participation in an advisory capacity or by limited legislation at the federal level in approving interstate compacts.

Industrial Water Supply

There are four sources of water upon which industry must depend to meet its present and future requirements. These are: [1] surface water, [2] underground water, [3] sea water and [4] water reclaimed from industrial and domestic sewage. A water conservation program, either local or national in scope, designed to accommodate the increasing industrial requirements, will prove inadequate unless all these sources are evaluated. One observer stated that "water shortages are due not to lack of water, but to lack of planning." There is much wisdom in

this conclusion. Critical problems related to inadequate water supplies in many areas can be solved, however, if wasteful practices are discontinued, and if industrial requirements are adequately planned and reasonably regulated by state and federal control.

Availability of Water and Industrial Consumption

The average annual rainfall over the country as a whole far exceeds any reasonable predicted demand for municipal and industrial water. It is estimated by the Weather Bureau that an average of about 30 in. of precipitation occurs annually over the United States. The U.S. Geological Survey records show that about 21.5 in. of rainfall soon returns to the atmosphere due to evapotranspiration and 8.5 in. runs off directly through streams, or through the ground and thence by streams to the oceans. It is estimated by the U.S. Geological Survey that approximately 0.75 in. is intercepted by water users throughout the country. The total consumption is in the magnitude of from 100 to 150 bil.gal. a day, of which industry uses 5 bil.gal. daily. About 25 bil.gal. a day is taken from the ground through wells and the remainder is supplied by surface water. This consumption does not include salt water usage from the ocean or salt water from underground sources (1). . . .

Warne (2) has drawn attention to "trouble spots" throughout the United States where heavy draft upon the water-bearing formations has resulted in the depletion of the underground water at a rapid rate. These areas include the Central Valley of California, the West Basin southwest of Los Angeles, the High Plains of Texas south of Amarillo, Grand Prairie region of Arkansas, certain areas of Long Island, N.Y., and elsewhere.

Warne (3) has forcefully voiced the danger of underground water exhaustion in critical areas. He states as follows:

The realization of adequate control over our ground waters should not be delayed indefinitely. The maintenance of the economy in areas dependent on ground water is hanging in the balance. Over short periods of time available reservoirs of ground water can be drawn down somewhat, without serious results. During years of unusually heavy precipitation, above-average replenishment of ground water may postpone the day of reckoning resulting from excessive withdrawals. But we would be shortsighted indeed if we failed to recognize that, to protect the heritage that rightfully belongs to the next generation, long-range solutions to these problems must be developed. The Department of the Interior will contribute to a broadened base for river basin and water resource planning in which proper account is taken of the potentialities and limitations of ground water utilization as well as those of surface water.

Based on the above observation and conclusion, a constructive program for the conservation of ground water is suggested. This is as follows:

1. Scientific investigation of our ground water resources.
2. Wide dissemination of the resulting data and principles.
3. Formulation of sound legal means of effecting desirable ground water control.

Factors Responsible for Water Shortages

Basically, the conditions responsible for water shortages to meet community requirements are:

1. Failure to provide for equalization of surface water runoff.
2. Overconcentration of population and industries.

3. Withdrawal of water from underground aquifers in excess of natural recharge.

4. Water wastage.

5. Failure to use available salt water in place of fresh water.

6. Selection of plant sites without adequate evaluation of availability of water for existing or predictable future requirements.

7. Inadequate design and planning of water-consuming processing equipment.

Effect of Concentration of Population and Industry on Water Consumption

It was reported recently (4) that from 1890 to 1940 the population of Texas increased 287 per cent [and] during the same period the demand for water rose over 7,000 per cent. Starting as is this increase, similar conditions, but of a lesser magnitude, have been experienced in many other communities. . . . Where ample surface water is available or where underground supplies are not pumped at a rate exceeding the natural recharge, such increased demands can be tolerated. Whether or not such increases in water requirements can continue to be satisfied, especially from underground water, depends on how intensely industries are concentrated. The late Dr. Meinzer (5) reported that:

About 10,000 communities, with about 75,000,000 inhabitants (1930 census), have public water works, . . . [of these] about 6,500 communities, with about 20,000,000 inhabitants, [being] supplied with ground water from wells. The total yielded by wells for public supplies is estimated at 2 bil.gal. a day.

As noted previously, heavy withdrawal of underground water in some

areas may be practiced without danger, but in other areas continued excessive pumping must, sooner or later, prove disastrous. In this connection, Guyton (1) has stated:

The truth is that there is no such thing as a nationwide depletion or shortage of ground water. Ground water is a replenishable resource and in most of the country there is still a lot to spare that percolates unused into streams and into the oceans or evaporates into the air.

There are, however, a good many places where problems have been created because users have attempted to take too much water from too small an area. As the storage has been used up, the supplies in these areas have been limited to the perennial recharge, and shortages have occurred because the recharge is not sufficient to meet all demands. Some of these shortages cannot be met economically by importation of water, and curtailment of existing industrial and agricultural development is in prospect. . . .

Instead of being faced with the national problem of reducing our ground water use, the problem is, rather, one of distributing the use so that overdevelopment of local areas can be eliminated or kept to a minimum and so that better advantage can be taken of the ground water that is now wasted by return to the atmosphere or through passing unused on its way to streams and thence to the sea.

Water Wastage

Much of the distress from declining water supplies could be greatly curtailed by reasonable economy and drastic control of water wastage. Millions of gallons of water now being wasted can be [saved] by reasonable conservation. In all cases where conservation methods have been practiced, the cost of supervision and control has been fully compensated for by dollar savings (6).

The American people, individually and collectively, have become the most

wasteful nation in the world. This habit is demonstrated by the use of both surface and underground waters. Our water wastage is strikingly illustrated by a comparison of the per capita consumption of water in cities in Europe and in this country. The average per capita water rate in ten European cities, including London, Paris, Vienna, Edinburgh and Berlin, before World War II, was 39 gpd., while in the same number of cities in this country it was 155 gpd. In the latter group are New York, Philadelphia, Baltimore, Chicago, Detroit and others.

The existing water shortage in New York City is in part added proof of extravagance and the urgent need for concerted effort to curtail water wastage. Water conservation by industries and all other groups will be reflected in savings which are commensurate with the effort made to avoid waste. Beyond the immediate financial return resulting from such action, there are the larger and more comprehensive benefits to be gained, such as the effect on the growth and development of communities and the overall welfare of the inhabitants. Without adequate water, specific limitations are imposed which retard the growth of all civic and industrial expansion.

No program of water conservation can be formulated which will be applicable to all communities or industries because the specific requirements vary widely.

Value of Flood Control for Industrial Supplies

Flood control projects have been established primarily to avert disaster from flood waters, but there are many resulting contingent benefits. Although not fully realized, conservation of flood water has a far-reaching effect, not

only in minimizing water shortages for industrial requirements but in improving water quality. By stream flow control, the effect of depreciation of water quality by industrial and sanitary wastes is reduced in accordance with the degree of regulation. One of the most direct benefits resulting from such regulation is the prevention of salt water intrusion into tidal rivers. It is a well known fact that salt water penetration into many fresh water streams results from insufficient river flows. During the severe drought of 1930 and 1931, the salt content in the Delaware River at Chester, Pa., rose to 1,860 ppm. This location is approximately 80 miles upstream from the mouth of the river. Normally, the salt content of the river in this area is less than 25 ppm. Such conditions are reflected directly in the cost of treatment of the supply. . . .

Substitution of Salt Water for Fresh Water

Many of industry's water requirements can be adequately fulfilled by salt water, where such supplies are available. To safely use brackish water, industrial equipment must be fabricated of material to resist the aggressiveness of the water. Many water shortages now existing in the seaboard area, and in locations where underground salt water is available, could be minimized or completely corrected merely by the use of the available salt water. No plant in a water-critical area should be designed to operate solely on fresh water when salt water is available. Obvious as is this water conservation measure, many seaboard plants use no salt water. The principal reason for failure to utilize such water is the increased cost of corrosion-resisting materials. Over an extended

period of time the use of salt water for many purposes can usually be justified, regardless of higher capital investments involved.

Laws Relating to Conservation of Underground Waters

Many laws relating to some phases of the withdrawal of underground waters are on the statute books but such regulations are either inadequate or not enforced in many critical areas. However, there is a gradual awakening with regard to the need for this type of important legislation. It is to be pointed out that any program for the conservation of water resources which may be developed on a national scale requires meticulous investigation into the needs of the various states or areas of the country, so that local requirements may be coordinated with the proposed national conservation policy.

Corrective Program

The water demanded for our expanding industries can and must be provided. The solution of the problem, involving as it does complex economic aspects, may only be found by an enlightened viewpoint reflected by industrial management and equitable, reasonable regulations. Such regulations must be imposed by mutual agreement and cooperative effort among those affected and by constructive long-term planning by municipal and state regulations. Within the last few years, aroused public concern over these deficiencies has prompted the assembly of much information on the subject. However, there are still many deficiencies. The data thus far compiled must be assembled and additional information collected before an accurate evaluation of the problem can be made and controlling measures established.

Studies in locations in which the water supply conditions are actually or potentially critical demonstrate the need for the inauguration of a program including:

1. An inventory of water requirements on a national basis coordinated with actual and potential water resources available, including both surface and ground waters. This survey should be both local and area-wise with respect to major river basins and geological formations.

2. Making available factual data regarding overindustrialization within critical, or potentially critical, water areas and the desirability of decentralization of industrial users of large volumes of water.

3. A study of the inter- and intra-state control and regulation of flood waters to provide present and future industrial water requirements, regardless of other benefits accruing from such facilities.

4. Publication of salt water usage as a conservation measure.

5. Expanding the activities of the state and federal agencies handling critical underground water resources problems.

6. Providing technical personnel for the U.S. Geological Survey and comparable state organizations, together with the necessary funds to effect more adequate utilization of the valuable services of these organizations.

7. Coordinating the activity of waste disposal regulation groups with those interested in resources.

References

1. GUYTON, W. F. Industrial Use of Ground Water. *Presented at Technical Assn. of Pulp and Paper Industry's Annual Meeting, Feb. 20-23, 1950.*
2. WARNE, WILLIAM E. Action on Ground

- Water Problems. Eng. News-Rec., (Feb. 17, 1949).
3. ———. Legal and Economic Problems Associated With Excessive Withdrawal From Ground Water Sources. *Presented at Inter-American Conf. on Conservation of Renewable Natural Resources, Denver, Colo., Sept. 7-20, 1948.*
 4. ABRAMS, ERNEST R. Is Texas Running Dry? Pub. Util. Fortnightly, **45:79** (Jan. 19, 1950).
 5. MEINZER, OSCAR EDWARD. Ground Water in the United States. Wtr. Supply Paper 836-D, U.S. Dept. of Interior, Washington, D.C.
 6. Factory Magazine (May 1950).

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Outline of Water Policy

The following is an excerpt from "A Water Policy for the American People," the report of the President's Water Resources Policy Commission (dated December 1950). A complete summary of recommendations by the commission will be published in the February 1951 JOURNAL.

Municipal water supply should continue to be primarily a local responsibility, including intercommunity cooperation through the formation of metropolitan water districts to make possible area-wide coordination of water supply sources to meet the needs of an increasing population. The growing needs of communities for water supply should, however, be considered in connection with the planning of all comprehensive basin programs. Their use of water from multiple-purpose reservoirs and improved stream flow should constitute a fully reimbursable service under such programs.

Possible future water requirements of large water-using industries should be considered as an important regional and national factor in connection with the planning of comprehensive basin programs. This should be particularly the case in regions where deposits of oil shales or other special resources point to industrial developments of significance to the nation's economic and military security.

The possibilities of contributing to municipal and industrial water supply and irrigation through recharging of ground water reservoirs and flows should be given full consideration in connection with all comprehensive basin planning. More complete knowledge of the country's ground water resources may open the way to ground water storage of surplus floodwaters as an important supplement to surface storage.

Adjustment of Water Treatment to Pollution Loading

Panel Discussion

A panel discussion presented on May 24, 1950, at the Annual Conference, Philadelphia, by Harry A. Faber, Research Chemist, The Chlorine Institute, Inc., New York; Kenneth C. Armstrong, Supt. of Filtration, Chester Munic. Authority, Chester, Pa.; Frank J. De Hooge, Supt., Filtration & Watershed, Passaic Valley Water Commission, Little Falls, N.J.; Edmund B. Evans, Water Purif. Supervisor, Water Works, Cincinnati, Ohio; Bryant L. Strother, Water Purif. Supervisor, E. I. du Pont de Nemours & Co., Richmond, Va.; Arthur R. Todd, Supt. of Filtration & Purif., Filtration Plant, Wheeling, W.Va.; and Donald B. Williams, In Charge of Purif., Water Works, Brantford, Ont.

Primary Considerations—Harry A. Faber

THE control of water quality has been aptly described (1) as a race between pollution and purification. The margin between the two contestants has, at times, been dangerously narrow. Pollution of surface supplies continues to increase, and the end of the race is not yet in sight. Only by the adjustment of water treatment to pollution loading has it been possible for purification to keep ahead of pollution.

In theory, the adjustment of water treatment to pollution loading would be a simple procedure. It would involve the proper design, construction and operation of a highly flexible water treatment plant including every physical, chemical and biological facility known to science. This ideal purification plant has never been provided by any municipality or industry.

Up to the present, it has been possible to purify polluted waters by the proper operation of conventional treatment plants employing conventional facilities. Future purification require-

ments may be even greater, however, and there is evidence that the demands imposed may be beyond the capacity of plants and facilities now provided. In these circumstances, it is important to consider basic requirements for the purification of polluted water; it is useful to evaluate methods employed for the adjustment of water treatment to pollution loading; and it may be essential to appraise methods of future utility.

Definition of Terms

Consideration of the basic requirements for the treatment of polluted water requires definitions of the terms employed:

Pollution is the fouling of natural water by wastes to such an extent that the water is rendered unsuitable for human consumption or for industrial purposes (2).

Water treatment is the processing of polluted water to the end that the water is rendered suitable for human consumption or for industrial purposes.

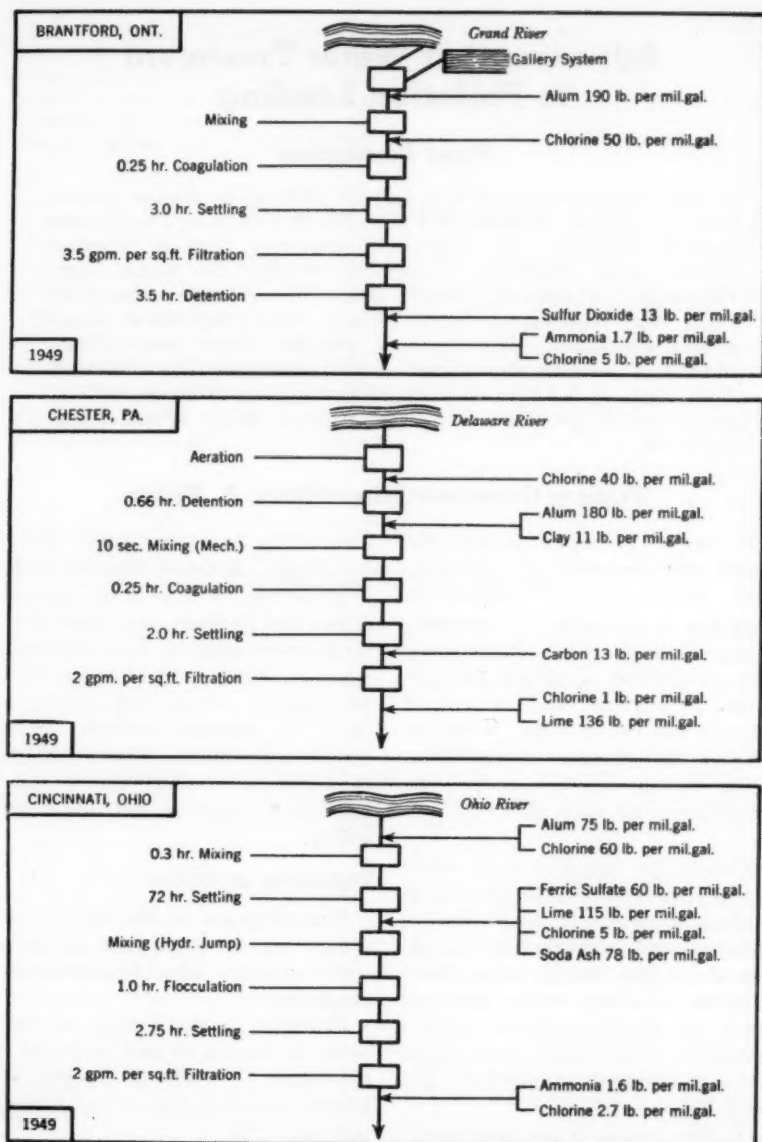


Fig. 1. Treatment Flow Diagram

Loading recognizes pollution to be a matter of degree, varying from light to heavy. In some respects, the pollution load can be evaluated rather precisely (as in the number of bacteria of the coliform group); and, in other respects, the pollution load is difficult to evaluate (as in the oxygen demand created by certain wastes).

Adjustment recognizes the necessity for alteration, specialization and critical control of water treatment in proportion to the pollution loading.

The relationship between these terms was clearly summarized in the statement by Gilbert and Sullivan that "the punishment must fit the crime"—that

Little Falls, N.J. Plant of the Passaic Valley Water Commission. Placed in operation, 1903. Treatment units added: primary coagulation basin, 1917; additional filters, 1921; prechlorination, 1937; lime after filtration and Clariflocculators, 1943. (See Fig. 2.)

Cincinnati, Ohio. Municipal plant. Placed in operation, 1907. Treatment units added: hydraulic jumps, flocculators and clarifiers, 1936; chlorinators for free residual chlorination, 1949. (See Fig. 1.)

Chester, Pa. Municipal plant. Placed in operation, 1918. Treatment units added: detention units and mixing units, 1933. Treatment units dis-

TABLE 1
Plant Capacity and Delivery

Plant	Rated Capacity mgd.		Water Treated (1949) mgd.		
	Original	Present	Avg.	Max.	Min.
Little Falls, N.J.	32.0	63.0	38.0	60.0	6.5
Cincinnati, Ohio	112.0	160.0	84.5	114.0	55.7
Chester, Pa.	12.5	12.5	10.5	11.9	8.3
Wheeling, W.Va.	20.0	20.0	9.4	17.5	6.0
Spruance Works, Va.	7.5	22.4	18.2	20.1	15.8
Brantford, Ont.	5.0	5.0	5.1	7.6	3.6

is, water treatment must be adjusted to the degree of pollution loading.

Basic Requirements

It would be desirable to illustrate the basic requirements for the purification of polluted water by means of a typical treatment plant, but none exists. Instead, a general description will be given of six plants where it has been necessary to adjust water treatment to heavy pollution loading. Together, these plants exemplify rather adequately the variety of treatment successfully employed in present practice.

These purification plants are, in order of age:

continued: secondary aeration, 1943. (See Fig. 1.)

Wheeling, W.Va. Municipal plant. Placed in operation, 1925. Treatment units added: none. (See Fig. 2.)

Spruance Works, Va. Industrial water purification plant of E. I. du Pont de Nemours and Co., near Richmond, Va. Placed in operation, 1929. Treatment units added: flocculators, coagulating units and filters, 1934; filters, 1939; detention units, coagulating units and filter, 1941; filters, 1943. (See Fig. 2.)

Brantford, Ont. Municipal plant. Placed in operation, 1931. Treatment units added: chlorinators for free resid-

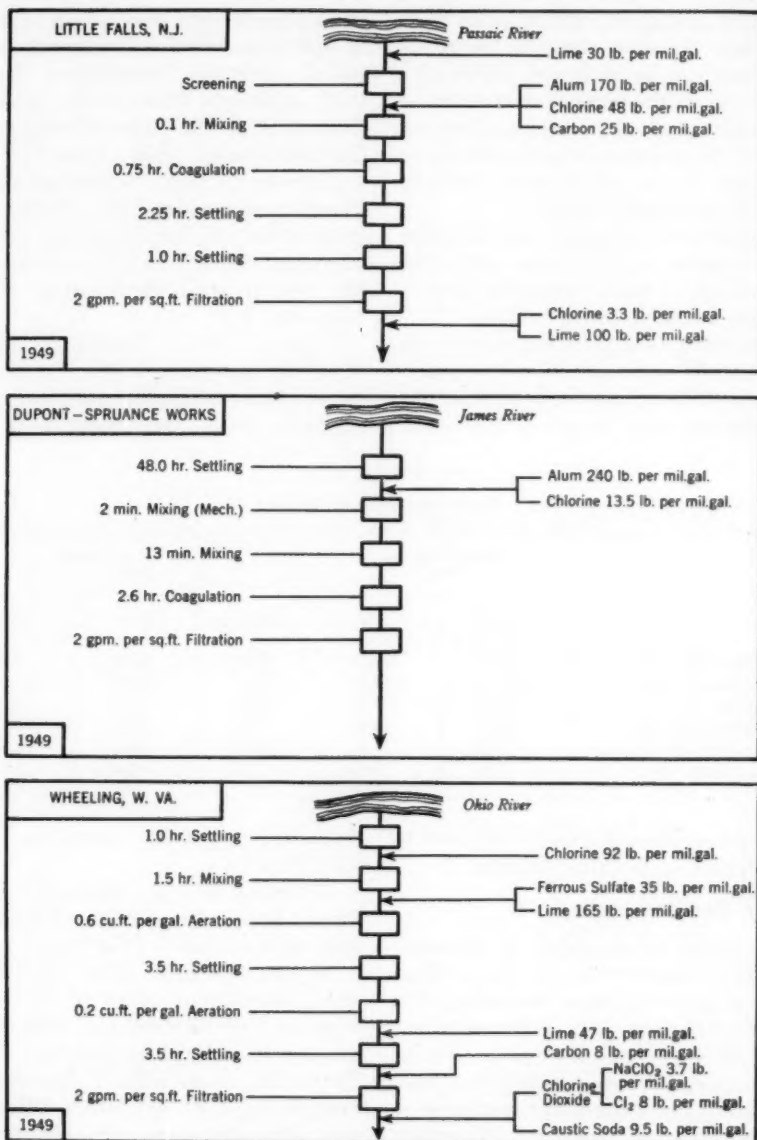


Fig. 2. Treatment Flow Diagram

TABLE 2
Coliform Organisms, 1949 Data

Water	Avg.	Max.	Min.
	M.P.N. per 100 ml.		
<i>Little Falls, N.J.</i>			
Raw water	5,000	24,000	650
Filter influent	0	0	0
Filter effluent	0	0	0
Delivered water	0	0	0
<i>Cincinnati, Ohio</i>			
Raw water	7,300	240,000	38
Filter influent	0	0	0
Filter effluent	0	0	0
Delivered water	0	0	0
<i>Wheeling, W. Va.</i>			
Raw water	36,500	1,000,000	10,000
Filter influent	0	0	0
Filter effluent	0	0	0
Delivered water	0	0	0
<i>Brantford, Ont.*</i>			
Raw water	500,000	5,000,000	10,000
	Significant Number		
<i>Chester, Pa.</i>			
Raw water	599	1,420	118
Filter influent	0	0	0
Filter effluent	0	0	0
Delivered water	0	0	0
	Phelps "B. coli" Index		
<i>Spruance Works, Va.</i>			
Raw water	894,000	10,000,000	100
Filtered water	0	0	0
Delivered water	0	0	0

* The laboratory of the Brantford plant is not equipped for bacteriological tests. These data are supplied by the Ontario Department of Health; the department regularly finds delivered water from the plant to be of safe sanitary quality.

ual chlorination, 1947; sulfonators for dechlorination, ammoniator and chlorinator for posttreatment, 1948. (See Fig. 1.)

The rated capacity of these six plants ranges from 5 to 160 mgd. (see Table

1). Three of the plants have been enlarged to meet water requirements greater than those originally provided for. In only one is the maximum daily amount of water treated greater than the rated capacity of the plant; in this plant, the average daily amount of water treated is the same as the rated plant capacity and the maximum treated is 50 per cent greater.

The number of coliform organisms in the water provides a measure of the pollution load. The average coliform content of the raw waters treated in these plants is high and, further, wide variation exists between the maximum and minimum content (Table 2). At every plant for which data are available, it is evident that preparation of the water for filtration accomplishes a spectacular degree of improvement in bacterial quality.

Certain physical and chemical characteristics of the raw waters treated in these plants are indicative of the pollution load. It is obvious from these data (Table 3) that no single characteristic can directly determine the purification requirements.

In addition to bacteriological, physical and chemical characteristics, there are less specific but equally significant qualities of the raw-water supply which present problems in the adjustment of water treatment to pollution loading. These qualities account for a lack of uniformity in purification practices and must be listed for each plant:

Little Falls, N.J. Coliform organisms have reached a maximum of 240,000 per 100 ml. The odor of the raw water is predominantly musty, and seasonal algae growths are characteristic.

Cincinnati, Ohio. Heavy algae concentrations occur seasonally, and taste- and odor-producing industrial wastes are constantly present.

Chester, Pa. Variations in raw wa-

ter quality (industrial and domestic pollution, taste and odor compounds, chlorides, and suspended solids not readily coagulated) correspond with tidal conditions.

Wheeling, W.Va. The phenol content of the raw water is 25 ppm., average; 400 ppm., maximum; and 0 ppm., minimum. It may range from 0 to 40 ppm. within a few hours. The manganese content is 0.2 ppm., average; 4.0 ppm., maximum; and 0 ppm., minimum. High acidity is characteristic of the water for a portion of each year.

Spruance Works, Va. Wide and rapid variations in the number of coliform organisms are a characteristic of this raw water supply.

Brantford, Ont. High and variable concentrations of algae present a serious problem: in summer live plankton counts reach 26,000 areal units; during winter floods, decaying *Cladophora* may be in excess of 100,000 areal units. Phenols are generally present. Domestic and industrial pollution contributes slow-reacting protein compounds which react with the high chlorine applications required for disinfection and produce nitrogen trichloride. The chlorine demand of the water varies rapidly.

A general conception of the treatment facilities and of the pollution loading at these six purification plants has been provided. Those in charge of the operation of the plants consider that the adjustment of water treatment to pollution loading could be improved. Obviously, the improvements contemplated reflect characteristics and limitations of specific plants:

Little Falls, N.J. Longer detention time is needed to receive the maximum benefits of free residual chlorination and to improve coagulation. The addition of activated carbon with provision of fifteen to twenty minutes' con-

TABLE 3
Physical and Chemical Characteristics,
1949 Data

Plant	Avg.	Max.	Min.
	Turbidity—ppm.		
Little Falls, N.J.	8	100	6
Cincinnati, Ohio	130	1200	3
Chester, Pa.	138	230	70
Wheeling, W.Va.	52	725	20
Spruance Works, Va.	45	700	4
Brantford, Ont.	5	230	1
pH			
Little Falls, N.J.	7.1	7.6	6.8
Cincinnati, Ohio	7.5	8.9	6.8
Chester, Pa.	6.6	6.7	6.4
Wheeling, W.Va.	6.5	7.3	4.1
Spruance Works, Va.	7.4	7.9	7.0
Brantford, Ont.	8.0	8.5	7.5
Threshold Odor			
Little Falls, N.J.	7	15	4
Cincinnati, Ohio	—	40	4
Chester, Pa.	69	125	30
Wheeling, W.Va.	40	400	20
Brantford, Ont.	40	90	20
Nitrogen (NH ₃ -N)—ppm.			
Little Falls, N.J.	0.32	0.80	0.08
Chester, Pa.	1.35	2.80	0.25
Wheeling, W.Va.	0.20	2.80	0.00
Brantford, Ont.	0.08	0.40	0.00
5-day B.O.D.—ppm.			
Little Falls, N.J.	3.0	4.0	1.9
Wheeling, W.Va.	3.4	13.5	1.8
Spruance Works, Va.	5.1	7.5	1.8

tact ahead of prechlorination may aid in taste and odor removal. Activated silica may be used to aid coagulation.

Cincinnati, Ohio. No additional treatment is presently contemplated.

Chester, Pa. Improved mixing facilities and longer detention time are

desirable. Free residual chlorination or other means of oxidation will be investigated. More efficient aeration would be beneficial.

Wheeling, W. Va. Longer detention time would be beneficial to present treatment processes. It has been suggested that the organic load in the raw water should be reduced by biological oxidation (as in a trickling filter) preceding the water treatment processes.

Spruance Works, Va. Treatment units have been added regularly in this industrial water treatment plant, and additional aeration is considered the only present need.

Brantford, Ont. An elevated storage tank, although not ordinarily considered a part of the treatment process, would be of material benefit in reducing the requirement for variation in pumpage. It will be desirable to improve coagulation (filters are now overloaded if raw-water turbidity exceeds 10 ppm.); to investigate the use of excess-lime treatment for the reduction of hardness and protein matter; and to determine the value of activated carbon for taste and odor control. Consideration is given to the use of biological oxidation (trickling filter or activated sludge treatment) preceding water treatment processes.

Summary of Requirements

A summary of the basic requirements for the adjustment of water treatment to pollution loading, predicated on a review of data from these plants, indicates:

1. Heavily polluted waters may be successfully treated in purification plants which employ conventional units for mixing, coagulating, settling and filtering.

2. Conventional water treatment chemicals are employed for coagulat-

ing, disinfecting and controlling taste and odor conditions.

3. Special provision is, or should be, made for long detention time ahead of filtration (in order to complete chemical reactions) and for flexibility of plant units (in order to vary the treatment processes).

4. Special provision is, or should be, made for employing a wide variety and heavy application of chemicals (in order to handle varying conditions and degrees of pollution).

Cost Considerations

Requirements for the successful treatment of heavily polluted water appear to differ only slightly from those for the treatment of waters not classified as heavily polluted. The treatment differs in degree rather than in type.

Jordan (3), in 1939, provided a basis for estimating costs of capital investment and operation for various types of water treatment plants. His classification of water treatment into five types assumed filtration to constitute a basic requirement. The treatment represented ranges from the most simple (Type 1)—involving coagulation, sedimentation and rapid sand filtration—to the most complex (Type 5)—involving the same requirements as Type 1, plus superchlorination, dechlorination, double coagulation and double sedimentation.

A 10-mgd. plant was used as the basis for Jordan's estimate, and it was pointed out that costs would be higher for a smaller plant and lower for a larger one. The capital investment for a 10-mgd. plant was estimated to be \$37,500 per million gallons per day capacity for the simplest plant and increased to \$48,500 per million gallons per day capacity for the most complex plant.

In 1939 it was considered that the total operating cost, exclusive of capital charges, of a pumped and filtered water supply approximated \$75 per million gallons. The total operating cost for the Type 1 plant included an estimated \$7.70, or about 10 per cent, as purification operating costs. The most complex treatment considered (Type 5) would increase the operating cost from \$75 per million gallons to \$83.30.

from low to high pollution load would increase the total cost by 11 per cent. The percentage increase in capital charges due to pollution load does not appear to be of greater magnitude.

Comparative data from the six plants treating heavily polluted water provide examples of actual chemical requirements. The amounts of chemicals applied are shown in Fig. 1 and 2, and the chemical costs are given in Table 4. Exceptionally high chemical costs ob-

TABLE 4
1949 Chemical Costs

Item	Cost—\$/mil.gal.					
	Brantford	Chester	Wheeling	Cincinnati	Little Falls	Spruance
Chlorine	7.03	3.06	2.61	2.22	1.87	0.51
Alum	3.60	2.97		1.16	2.82	4.47
Lime		1.09	1.12	0.79	0.86	
Activated carbon		.75	0.06	0.72	0.53	
Ammonia	0.42			0.24		
Ferric sulfate				0.81		
Ferrous sulfate			0.39			
Soda ash				1.23		
Caustic soda			0.31			
Sulfur dioxide	2.80					
Sodium chlorite			2.76			
Clay		0.09				
Aeration			0.50			
Total	13.85	7.96	7.75	7.17	5.69	4.98

The estimated costs of chemicals required for treatment varied from \$2.70 per million gallons for a Type 1 plant to \$9.00 for Type 5. Estimated labor costs varied from \$5.00 to \$7.00 per million gallons for the same types of plants.

Jordan's analysis indicates that the variation in the cost of water treatment due to increases in pollution load is not so great as might be casually assumed. Considered in relation to the total costs of producing, distributing, billing and managing a water plant, the variation

at the Brantford plant, partly because of its small size but more particularly because of the relatively higher price of chemicals in Canada. The chemical costs reported by these plants, except for Brantford, are well below the \$9.00 per million gallons estimated for the most complex type of plant.

Data from the six plants treating heavily polluted water also indicate that chemical treatment costs per million gallons have, in general, increased materially in the past 30 years and especially in the last decade. The Spruance

plant is an exception to this trend, its chemical treatment costs having remained practically constant.

The increased cost of chemical treatment is due to the application of chemicals in larger amount and variety. It is evident that the amount and variety of chemicals required has varied to a major extent with the pollution loading, and, to some extent, has been increased to meet higher standards of water quality.

Variation in the price of water treatment chemicals has not been responsible for increased costs of chemical treatment. Alum, ferric sulfate, fer-

rous sulfate, lime and ammonia have remained unchanged in price in the past 30 years. Activated carbon, of greater adsorption efficiency, is priced the same as was less efficient carbon 20 years ago. Chlorine decreased in price between 1920 and 1930, remained stable until 1946 and has now increased about 20 per cent in cost.

many means of providing water of high bacterial quality ahead of filtration. But the range in requirement for this chemical (Table 5) illustrates the variable effect of raw-water characteristics and of related treatment methods. At Wheeling, the chlorine applied averages 100 lb. per million gallons (12 ppm.), but the coagulant applied (ferrous sulfate) averages only 35 lb. per million gallons (4.2 ppm.). At the Spruance Works, the chlorine applied averages 13.5 lb. per million gallons (1.6 ppm.), but the coagulant applied (alum) averages 240 lb. per million gallons (29 ppm.).

For coagulation, five plants employ alum (one employing ferric sulfate in conjunction with alum), and one plant employs ferrous sulfate. Four plants employ lime (one applying it only for final pH correction). Four utilize activated carbon for taste and odor control. Two plants apply ammonia for combined residual chlorination of the finished water. Employed at only one plant is each of the following: soda ash, caustic soda, sulfur dioxide, sodium chlorite and clay.

Special physical and chemical treatment facilities provided at these purification plants include:

Little Falls, N.J. Double sedimentation; pretreatment by free residual chlorination.

Cincinnati, Ohio. Double coagulation; double sedimentation, with the first period exceptionally long (72 hours); pretreatment by free residual chlorination.

Chester, Pa. Detention unit for chlorine reaction before coagulation; use of clay as a coagulant aid.

Wheeling, W.Va. Triple sedimentation; pretreatment by free residual chlorination; posttreatment by chlorine dioxide.

TABLE 5
Average Chlorine Applied, 1949

Plant	Chlorine Applied	
	lb./mil.gal.	ppm.
Wheeling, W.Va.	100.0	12
Cincinnati, Ohio	67.7	8.1
Brantford, Ont.	55.0	6.6
Little Falls, N.J.	51.3	6.2
Chester, Pa.	41.0	4.9
Spruance Works, Va.	13.5	1.6

rous sulfate, lime and ammonia have remained unchanged in price in the past 30 years. Activated carbon, of greater adsorption efficiency, is priced the same as was less efficient carbon 20 years ago. Chlorine decreased in price between 1920 and 1930, remained stable until 1946 and has now increased about 20 per cent in cost.

Evaluation of Methods

In the specific water purification plants reviewed, adjustment of water treatment to pollution loading appears to depend more directly upon chemical conditioning than upon any other factor. Chlorination is utilized as the pri-

Spruance Works, Va. Double sedimentation, with the first period exceptionally long (48 hours); industrial condenser cooling water recirculated to and from first sedimentation unit, providing aeration and higher than normal temperatures for coagulation reactions.

Brantford, Ont. A new method of odor control, developed at this plant (4), which involves free residual chlorination, complete dechlorination, ammoniation and rechlorination.

At each of these purification plants, the conventional filtration rate of 2 gpm. per square foot is employed. There is evidence, in the data presented, that even higher rates of filtration may be employed when heavily polluted raw waters are effectively conditioned by pretreatment processes.

It is impossible to evaluate on a comparative basis the methods employed in these plants. The adjustment of water treatment to pollution loading must be determined by physical and chemical limitations. The treatment units provided in the purification plant create physical limitations, and the response of pollution to chemical conditioning creates chemical limitations. These plants do demonstrate that very flexible purification processes can be provided by physical and chemical methods in suitable combination.

Future Outlook

There must be a limit, however, to the degree of purification which can be accomplished by physical and chemical treatment. This condition has already been demonstrated in processes for the treatment of sewage and industrial wastes. If the pollution of surface waters becomes more intensified, biological methods may be required for further adjustment of water treatment processes.

The dividing line between polluted water and sewage effluents or industrial wastes may be very narrow. It has been suggested that, at Wheeling (5), the organic load in the raw-water supply should be reduced by sewage treatment methods ahead of water treatment methods. Reports are now available giving details of the study of a full-scale biological treatment process for just such a purpose.

In 1945 Pugh (6) described the scheme of Coventry, England, to treat water from the River Avon at Ryton. He titled his paper "The Treatment of Doubtful Waters for Public Supply." The Ryton supply, originally 1 mgd. and later 2 mgd., was developed as a wartime emergency measure. The raw water was limited in quantity, varied widely in quality and required the provision of very flexible treatment. It was the only immediately available source of supply.

The treatment provided included coagulation, settling and free residual chlorination. The free residual chlorination process employed was markedly affected by the ammonia content of the raw water: at low ammonia concentrations, the application of 4 ppm. of chlorine produced the necessary residual of free available chlorine, while at high ammonia concentrations, the application of over 50 ppm. of chlorine was required to provide free residual chlorination. The association of phenols with high ammonia concentrations introduced another complicating factor. Studies were undertaken to determine the value of biological pretreatment of this raw water, first in an experimental filter and later in one of pilot plant scale.

In 1949 Pugh (7) reported the results of operation of a full-scale "biological filter" over a three-year period. The pretreatment of the river water in

this unit was found to produce several beneficial effects:

1. Oxidation accomplished a material reduction in the concentration of free and saline ammonia and nitrites.
2. The pH value of the water was reduced and stabilized.
3. Bacterial numbers were materially reduced.
4. Phenols were eliminated from the water.

The great improvement in "treatability" of a doubtful raw water by natural means and at very little cost justifies consideration of biological pretreatment as a feature of water works construction. Pugh recommended that the design of such biological filters should be given careful consideration and that alternative methods, such as activated sludge processes, should be investigated.

Conclusion

Data from six plants which treat heavily polluted water demonstrate that the adjustment of water treatment to pollution loading can be accomplished in conventional plants using conventional facilities. The treatment employed differs in degree rather than in type, as compared with more lightly polluted waters. Chemical requirements, for the treatment of heavily polluted waters, appear to increase the total costs of water supply operation to only a minor extent.

The data also show that varied combinations of processes may be successfully employed for the treatment of heavily polluted water. Long periods of detention and flexible operating facilities constitute important provisions.

The degree of purification which can be accomplished by further extension of physical and chemical methods may be rather limited. Adjustment of water treatment to pollution loading may,

in the future, require the use of biological treatment processes in conjunction with water treatment processes. The utility of this combination has already been demonstrated.

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References

1. FILIPI, T. A. Panel Discussion—Factors Involved in Control of Water Supply Quality. *Jour. A.W.W.A.*, **41**:889 (Oct. 1949).
2. *Water Quality and Treatment: A.W.W.A. Manual*. American Water Works Assn., New York (2nd ed., 1950).
3. JORDAN, HARRY E. "Basis for Estimates of Costs of Capital Investment and Operation for Various Types of Water Treatment Plants," in *Water Pollution in the United States* (Appendix 2). National Resources Committee. House Doc. 155, 76 Cong. 1. U.S. Govt. Printing Office, Washington, D.C. (1939).
4. WILLIAMS, D. B. A New Method of Odor Control. *Jour. A.W.W.A.*, **41**:441 (May 1949).
5. TODD, A. R. Present Condition of the Ohio River. *Jour. A.W.W.A.*, **38**:41 (Jan. 1946).
6. PUGH, NORMAN J. Treatment of Doubtful Waters for Public Supplies. *Trans. Inst. Wtr. Engrs.*, **50**:80 (1945).
7. ———. The Treatment of Doubtful Waters for Public Supplies. *J. Inst. Wtr. Engrs.*, **3**:123 (1949).

Chester, Pa.—Kenneth C. Armstrong

The Chester, Pa., filtration plant is located on the Delaware River approximately fifteen miles below the center of Philadelphia. The Delaware at this point has long been considered unsuitable as a source of supply because of pollution and the encroachment of salt water up the bay during dry weather. The salt from the sea has become so prevalent and is in such concentration it has been necessary to develop another supply, which is about half completed at this time. Otherwise, more research and plant improvement would have been accomplished since the war.

The best measure of pollution at hand is the chlorine demand, which, in

increase in chlorine dosage. First is the low flow of the river in the 1940's, as evidenced by the encroachment of salt water. For only two years during the decade was the supply free from salt. Concentrations as high as 1,500 ppm. of chlorine as chloride were encountered. Concentrations in varying amounts occurred up to four months per year. Second, in addition to the normal rise in pollution by domestic sewage and industrial wastes, there was the dumping of immense quantities of grain wastes by the alcohol industry. In 1940-44 the capacity of the river was overtaxed, resulting in complete oxygen depletion, the formation of hydrogen sulfide which ruined paint on

TABLE 1
Chlorine Dosages, 1930-49

Period	Avg. Dosage ppm.	Increase per cent	Peak Month Dosage ppm.	Increase per cent
1930-34	1.96		3.47	
1935-39	2.11	8	4.06	17
1940-44	3.47	77	10.9	214
1945-49	3.2	63	6.2	78

the course of a normal year, remains fairly constant during average river flow and rises during the months of least rainfall, usually in the late summer and autumn. There was a slight rise in chlorine demand in the ten years 1930-39. In the period 1940-44 a sharp increase took place, while a considerable reduction was evident in 1945-49. Table 1 shows the average chlorine dosages over the twenty-year period 1930-49 for intervals of five years, as well as average dosages for the peak month of each five-year interval. The percentages of increase in dosage are in terms of the 1930-34 interval.

There are two main reasons for the

buildings and ships, and indescribable odors of pig pen and outhouse varieties which could not be removed by any treatment.

These conditions abated in 1945 and 1946, but, later in the decade, waste from the fermentation of molasses almost turned the river over again. For a few days in September 1948 coagulation became very inefficient, but when waste recovery equipment was installed conditions improved. In the first part of the 1930-34 period, troubles from odors and tastes and fouling of filters were experienced. The treatment at that time included mixing, aeration, sedimentation for two hours, filtration, chlorination and pH

adjustment. Later in the period the plant was revamped for five years of service, with the aim of changing to a new source of supply. Plant operation then consisted of aeration, contact with chlorine for 40 minutes, mixing with clay and coagulant, slow mixing for 20 minutes, aeration, sedimentation for two hours, filtration, chlorination and pH adjustment. The same treatment schedule was followed in 1935-39, except that carbon was used on the filters. At the end of this period, the wash water ratio rose as high as 10 per cent, which reduced the capacity of the plant to 9 mgd., although the normal rating was 12.5 mgd.

Early in the 1940-44 period sweeps were installed in the filters, which have kept them clean in spite of the heavy load of filth that has been handled. A 3-in. layer of Anthrafil^{*} placed over the sand resulted in increased filter runs at first, but later, when coagulation deteriorated, it permitted much material to pass through the filters. After improved coagulation was achieved, however, the use of Anthrafil became a decided advantage. It is the answer to the problem of heavy loading of filters by well formed floc, but surface wash is necessary when it is used.

In December 1942 the filtration rate had reached 10 mgd., the settled-water turbidity was 42 ppm. and the effluent turbidity, 11 ppm. To make matters worse, filters were constantly being broken through. The trouble was clearly due to overloading by improperly coagulated turbidity. Immediate steps were taken to correct the condition. First, the secondary aerators were bypassed, making it necessary to lower the level of the tangential flow mixers by 4 ft., thus cutting off 30 per

cent of their detention. Settled-water turbidity dropped 40 per cent and a clear filter effluent resulted. Second, a very effective flash mix was created by baffling the primary mixing flume, using some of the head made available by the first change. Third, provision was made for a steady stream of coagulant solution to the flash mix, a detail which is often overlooked but is very important for a flash mix of short duration, especially when part of the suspended material does not respond well to coagulation. Fourth, the effectiveness of the sedimentation was greatly improved by a rapid method of removing sludge through the use of a portable 6-in. pump which served as a booster in the drain. Fifth, baffling the entrance of the sedimentation basins with slats reduced short-circuiting. And sixth, a general overhauling of mechanical equipment all but eliminated shutdowns, which had been frequent before.

These changes have resulted in easier and more efficient operation. No trouble has been experienced in getting proper clarification, except for short periods during the peaks of grain and molasses pollution. In 1949 the highest monthly average of settled-water turbidity was 16 ppm. and the average filter run was 27 hours, all filters being washed at 35 hours.

One disadvantage of the changes was the supersaturation of the settled water with air. This was caused by the extra head resulting from the changes mentioned. The water dropped a greater distance from the primary aerators to the piping leading to the contact tanks, entrapping more air and forcing it into solution as the water and air passed through areas under several feet of head. This air later came out of solution in the sedimentation basins, causing floating floc, and in the filters,

^{*}A product of Anthracite Equipment Corp., Wilkes-Barre, Pa.

causing air binding. No serious problem of operation has resulted except for the shortening of the filter runs.

Demand climbed steadily during and after the war but has slowed down materially in the past year. The highest monthly rate was 11.6 mgd. and the highest daily rate, 13.6 mgd. Coagulant dosage has decreased materially since the changes were made. The river, at present, is in the best condition that the author has encountered during his eight years at the plant.

The measures taken to meet the terrible conditions of the past decade, in reality, have been an effort to put an antique plant in a state of modern efficiency. Only partial success has been achieved but the results have been sufficient to prove that the problems of filtration were due more to plant deficiency than to any other cause. If such quantities of waste had been discharged into a stream which did not coagulate well in its natural state, however, the problem of treatment would have been more difficult, no matter how good the treatment plant.

Little Falls, N.J.—Frank J. De Hooge

The Passaic River at Little Falls, N.J., has been furnishing potable water to the three partner cities which own the supply—Paterson, Passaic and Clifton—and to at least ten other neighboring communities in the northern New Jersey area.

In 1857, when the system was inaugurated by the Passaic Water Co., untreated water was supplied from an intake located in Paterson at the great falls. Forty years later, in 1897, the intake was moved upstream 5 miles to Little Falls, where a pumping station was built in 1899. The filter plant, consisting of 32 gravity rapid sand filters, with air wash, was put into service

The combined chlorine residual is kept as near 1 ppm. as possible in the settled water, the dosage of chlorine in the clear well being just enough to bring the final product up to 1 ppm. Maintaining proper residuals has kept the operators on their toes during periods when there was wide variation in demand at different stages of the tide. Chlorination equipment has been carefully maintained, all machines being thoroughly tested after repairs. Standby machines are always ready for service.

Bacterial removal has been well within the present standards. Plant records show a yearly average for eight years of 5 confirmed tests in 1,825 10-ml. lactose broth tubes. Samples collected in the distribution system indicate that it is in good condition bacteriologically.

Throughout this trying period a safe water has been produced. But, in these days, the public rightfully demands a palatable water as well. No customers have been encountered who relished a product with 1,000 ppm. of chlorides.

during September 1902. The plant began operating at a 12-mgd. rate, but during World War I it reached its capacity of 32 mgd. A new coagulation basin of 5.2-mil.gal. capacity was built in 1917, and work began on the construction of ten additional filters of 1.5-mgd. capacity. These were of the Wheeler bottom type with a high-velocity wash. Changes were effected in the 32 original filters, new controllers were installed, and the rate of filtration was increased until the plant capacity rose to 60 mgd. As the use of water continued to mount, 32 additional pressure filters, each of 0.5-mgd. capacity, were constructed in 1927,

bringing the plant capacity up to 79 mgd. The greatest daily pumpage from this source—89 mgd.—occurred while supplying Jersey City during an emergency on July 12, 1934.

The Passaic Valley Water Commission's other source of supply, the Wanaque, was used during 1932-40, the 37.75 mgd. from this source being ample to meet all the requirements for water during that period. When World War II began, the water demand once more reached the heights, and, beginning in 1941, the Passaic River supplied the area again with upwards of 40 mgd. This supply has averaged 57 mgd. since November 1949.

The Passaic River has a total drainage area of more than 760 square miles, of which 495 constitute the area appropriated for Passaic Valley Water Commission use. The Wanaque, Rockaway and Pequannock Rivers are used for potable purposes by Newark and Jersey City. Six rivers make up the Passaic at Little Falls: the Wanaque, Pequannock, Ramapo, Rockaway, Whippany and Pompton. Average rainfall is approximately 48 in. a year, and the river flow varies from a maximum of 12,000 cfs. to a minimum of 100. The population per square mile in 1920 was 167, which by 1940 had increased to 332, not in any one section, but distributed generally over the entire watershed area. The past few years have seen a number of new housing developments, totaling hundreds of

homes, so that by 1952 it is estimated that the population per square mile may reach 350.

The Little Falls supply is considered soft and is most suitable for the silk-dyeing industry in Paterson. The color is average for most river waters, rarely exceeding 60 ppm. and dropping as low as 15 ppm. for short periods. The pH is between 6.8 and 7.2, 90 per cent of the time. The turbidity is low, reaching a high of 100 after heavy runoff and a low of 6 during winter months, the average being 8 ppm. Algae growths are average, with trouble most likely in late spring and summer. In recent years the treatment used at the plant has never failed to produce a palatable water.

There are more than 150 industrial plants on the entire watershed, including paper mills, rubber reclaiming plants, dye works, slaughterhouses, dairies, creameries, chemical plants and electroplating plants. They have at times caused trouble in treatment, but, generally speaking, the program of pollution abatement now in force continues to show great progress.

The absence of waterborne diseases throughout the district supplied by the Passaic Valley Water Commission since 1903 verifies the fact that the Passaic River at Little Falls, with the prevailing treatment facilities, processes and pollution control, has been and is satisfactory in all respects in relation to public health.

Cincinnati, Ohio—Edmund B. Evans

The extensive contamination and pollution of the Ohio River due to the constant and increasing discharge of untreated domestic and industrial wastes into it and its tributaries have caused many problems for the water works using this river as a source of supply. For years reports have mentioned the

nauseating, distasteful and odoriferous water resulting from pollution. The nuisances were characterized as phenolic, oily or kerosene-like, chlorophenolic and chemical waste. Also, vegetable or algal tastes and odors have been very prevalent since 1917.

In 1926 Cincinnati tried suspending

the postchlorination process and resorted to double coagulation and excess-lime treatments. The tastes were very intense in the raw water, however, and the elimination of the disinfection process gave little, if any, relief. Unprecedented difficulty was encountered in 1929 with profuse vegetable life in the river. In August of that year filter runs on some days averaged less than six hours even after three breakings of the bed by an upward spurt of wash water during the run. High applications of primary and secondary coagulants did not coagulate the vegetable cells, and the full load was carried to the sorely overburdened filters. Chlorination of the raw water below the "breakpoint" in the gravity settling reservoirs for four days increased the runs to seventeen hours but a speedy shortening occurred as soon as the chlorination was stopped. This treatment was abandoned because of the bad tastes imparted to the water. On the worst day, there were 95 filter washes and 200 breakings of the sand beds.

In the year 1930 postchlorination was again stopped for a time, but with little success. Also, during the summer of that year, short filter runs led the department to try out the idea of "artificial turbidity" production in the primary gravity settling reservoirs for fourteen days. Mud was lifted from the reservoir bottom and distributed over the water surface by a gasoline-driven centrifugal pump with a 4-in. discharge, mounted on a raft which was propelled by an outboard motor. The method was inadequate to muddy a reservoir having a surface area of 23 acres. A turbidity of less than 30 ppm. was produced at the coagulation basins, even when discharging the mud near the outlet tubes of the reservoirs, and the putrescent mud lifted from the res-

ervoir bottom imparted tastes and odors to the water. The ten-hour filter runs were increased to only fifteen.

The ammonia-chlorine process was somewhat successful in lessening the phenolic tastes in 1931 but did not remove them. In that year, activated carbon treatment was first tried and proved quite effective in removing algal tastes, as it did in 1933, when 5.5-ppm. doses were applied at the entrance to the coagulation basins. These basins had no mechanical equipment in them.

Rehabilitation of Plant

During the five years 1938-42, 14-ppm. carbon doses did not accomplish complete removal of the decidedly oily or kerosene-like tastes and odors, and laboratory studies indicated that at least 20 ppm. was needed. Under market conditions at that time, it would have been impossible to receive replenishing shipments fast enough to permit the use of six tons per day for any lengthy period, and the daily cost would have reached \$530.

The experiences of the period 1943-47 were no different from those of previous years. The same problems continually recur in a stream as variable as the Ohio, subject to whether the precipitation is excessive, deficient or normal. As long as dilution is depended on in disposing of trade wastes, this will always be true. Although there is some respite when the rainfall is excessive, from year to year the tastes and odors become more intense and of longer duration.

Free Residual Chlorination

During 1943-47, in addition to the previously mentioned pollutants, two new troublemakers were found—styrene and butadiene. Probably many other unidentified wastes caused dis-

tasteful water, but these two were most aggressive and produced characteristic tastes and odors. Laboratory experiments showed the concentrations of the two compounds to be of such magnitude that a carbon dosage of 60 ppm. would have been necessary to give a passable, palatable water, requiring 50,000 lb. of carbon per day at the plant operating rate.

Of course, treatment with activated carbon in such quantities was entirely out of consideration. Therefore, laboratory studies on the chlorination of raw-water samples were undertaken in March 1944 for the purpose of determining the feasibility of using free residual chlorination to eliminate the taste and odor conditions, and the chlorine requirements of this process at various possible points of application in the filtration plant. The studies were made with the cooperation of Wallace and Tiernan Co. engineers and research chemists.

From January 27 to February 16, 1945, pilot plant studies on odor removal by diffused-air aeration were made at the Cincinnati Water Works by the U.S. Public Health Service. These studies showed that, at the temperatures encountered during the winter season, Ohio River water could not be successfully treated in this way.

Further prechlorination studies indicated that free residual chlorination would be practical, and it was decided in 1946 to go ahead with plans. The approval of the chief engineer of the Ohio Dept. of Health was obtained, and on December 1, 1946, specifications were drawn up. Inability to procure materials forced the work to be delayed many times, but on February 10, 1949, the process of treating the raw water with chlorine was started. A dose of 6 ppm. of chlorine was applied, amounting to 4,200 lb. of chlo-

rine per day for an 84-mgd. rate of production.

This was an eventful day in the history of the Cincinnati Water Works because it meant that an effective method of reducing or eliminating the medicinal or chemical tastes and odors in the raw water had been found. In fact, the results so far obtained by free residual chlorination have even exceeded the department's greatest expectations. The monthly maximum chlorine demand of the raw water after seven minutes' contact has averaged 4.5 ppm. and the monthly minimum, 1.2 ppm.

Free residual chlorination has enabled the filters to operate for a much longer period and at a greater loss of head. During 1949 the head loss reached 8 ft. at a 4-mil.gal. rate. The maximum period of service at this loss of head was 124.7 hours, the minimum being 16.2 hours. Before free residual chlorination was adopted minimum runs of 1.5 hours were quite often encountered at a 6-ft. loss of head.

Naturally, this lengthening of filter runs has decreased the number of washings and, therefore, the percentage of wash water used. The months of September and October 1948 may be compared with the same months in 1949, when somewhat similar algal conditions existed. In 1948 neither alum nor chlorine was added to the raw water, only the normal treatment (14 ppm.) of Ferri-Floc* being applied in the coagulation basins. In 1949, however, 6 ppm. of alum was applied to the raw water, which was chlorinated; the water was then treated with 4.3 ppm. of Ferri-Floc. The number of filter washes in September and October 1948 was 3,436 and 1,651,

* A product of the Tennessee Corp., Atlanta, Ga.

respectively, while in the same two months of 1949 it was 531 and 464, respectively. For eleven months of 1949, February to December inclusive, when the raw water was prechlorinated, only 3,643 filter washes were made, while in the same period of 1948 the number was 9,942.

Formerly plant operation and chemi-

cals applied were based on the bacterial load of the water entering the coagulation basins. Since the chlorination program has been in effect, however, this factor has been eliminated from consideration, because the coliform indexes of the primary-settled, treated and filtered waters have been zero.

Spruance Works, Va.—Bryant L. Strother

The Spruance Works of the E. I. du Pont Co. is located 6 miles south of Richmond, Va., on U.S. Highway No. 1. The property extends eastward to the James River. Textile rayon, Cordura tire cord and Cellophane film are manufactured on the location by the viscose process. Yarns and film made by this process have to be washed free of impurities such as sulfuric acid before being shipped to the consumers. Therefore, an ample supply of highly purified water is a basic and constant need.

Raw water is supplied to the plant location from the James River by pumping through a 36-in. line, 7,600 ft. in length. The raw-water intake is located 5 miles below Richmond's sewer discharge, and raw, untreated domestic and industrial wastes from a city with a population of 240,000 are discharged directly into the stream. Since the river intake is located in a tidewater area, the ebb and flood conditions cause the wastes to pass back and forth through the intake area, thereby resulting in a continuous addition of fresh pollution to the already polluted river.

As early as 1928 Virginia Health Dept. officials recognized that the stretch of river from which the raw water is obtained was an open septic tank, being the zone of highest bacterial concentration below the city's sewer outfalls. In the autumn of 1947

a cooperative study made by the Virginia Water Control Board, the state health department, the city of Richmond and the du Pont Co. proved conclusively that the maximum concentration of coliform organisms occurs in the river at a point approximately 1,000 ft. below the du Pont pumphouse. Expressed in terms of M.P.N., the coliform population found at that point was 6,000,000. This figure was obtained by averaging eighteen series of tests over a three-month period, with normal water flows and falling temperatures. Further tests are planned at some future date when high temperatures and low flows coincide. Nitrogen results obtained during the study period were normal, as had been expected. The ammonia increased in and below Richmond and then was converted further downstream into nitrites and eventually into nitrates, according to the nitrogen cycle. Following the bacterial increase in the stream, there was a rise in biochemical oxygen demand, which decreased as the river recovered below Richmond. No conclusions were drawn about the dissolved-oxygen content of the stream because the study period did not include hot-weather and low-flow conditions, under which the measurement would reach its principal significance.

Although the raw-water picture is not one to be regarded with favor by public health department officials, the

results obtained in the water purification plant have shown that water from such a source can be treated satisfactorily and made safe for domestic and industrial use. Approximately 0.1 per cent of the water purified is used domestically, and carefully kept medical records show no ill effects suffered by its more than 4,500 consumers.

The water system may be briefly described. Pumps deliver the river water to a 35-mil.gal. open reservoir. The water enters at the head of the reservoir and flows for a distance of 1,600 ft. to a pump suction crib, from which it is pumped to the powerhouse ammonia condensers. From the ammonia condensers' hot well, the water is pumped to the filter plant. Alum and chlorine are then added to the influent and pass with it into two mechanical mixing chambers. These chambers have variable-speed vertical paddles which mix the chemicals with the water thoroughly for a period (with present loads) of between two and three minutes. Paddle speeds may be varied from 1.9 to 5.9 ppm. After mechanical mixing the water passes through several separate, three-pass, over-and-under and around-the-end types of contact chambers and then into the coagulation or settling basins. The basins, equipped with slotted baffles at both inlet and outlet ends, discharge into a box flume common to all basins and to all filter influent valves. Twelve 1.6-mgd. filters, loaded with Anthra-filt and sand, discharge the filtered water into a 1.2-mil.gal. underground clear well from which service pumps supply the various water demands. In passing, it might be stated that ten of the twelve filters have Leopold bottoms and the other two, Wheeler bottoms.

Alum and soda are fed by means of dry-feed machines. Three chlorinators

and two ammoniators feed the necessary sterilizing reagents. Neither soda nor ammonia is fed continuously.

Some of the unusual features of the system may be of interest. The 35-mil.gal. reservoir also serves as a spray pond for turbine condenser water and, during hot-weather periods, the spray pumps, located approximately midway of the reservoir, provide excellent aeration for the raw water passing through the lake. The suction crib for the reservoir pumps supplying the ammonia condensers is equipped with three gates, each opening at a different level, which gives a degree of flexibility in the choice of the water to be taken. The passage of the raw water through the straight-tube, surface ammonia condensers provides some additional aeration. An average overall reduction of 79.66 per cent in coliform organisms without the addition of any sterilizing agent was obtained through these unusual features of the plant during 1949.

Standard bacteriological tests are run in the filter plant laboratory, as well as more rigid tests on larger volumes of water than those required by the U.S. Public Health Service. Samples are submitted twice weekly to the state authorities for examination. Since the plant went into operation more than twenty years ago, the company medical department has recorded no illness on the part of employees or their families attributable to the water furnished by the plant. Chlorine additions to the raw water (by weight) are checked hourly and residual chlorine sterilizing compounds are checked at two-hour intervals.

With proper equipment and eternal vigilance by both operators and supervisors alike, the James River and others like it can be and are being purified to meet the most rigid effluent standards.

Wheeling, W. Va.—Arthur R. Todd

Wheeling's attempt to furnish its citizens with a safe and palatable water met with numerous failures until 1941. It was then realized that the reason a method of purification which worked beautifully one year proved a rank failure the next was that the Ohio River was becoming more grossly polluted each succeeding year. Upon grasping this all-important fact, half of the battle for a better-tasting water was won. Future increased pollution loading could be anticipated and plans could be made to solve the resulting problems.

Until 1918 the Ohio River supply for Wheeling was used directly without filtration, purification or chlorination. It is recalled that in 1913 the surface of the river became covered with dead, stinking fish, an incident referred to as the big "fish kill." There have been many smaller kills since then—smaller because there were fewer fish in the river. The fish kills are due to a change in the river water from alkaline to acid. Moreover, the number of typhoid fever victims was increasing at an alarming rate until 1918, when chlorination was first adopted.

In March 1925 the present rapid sand filtration plant was put into operation. During its 25 years of service more than 87.5 bilgal. of water has passed through the plant. Not a single case of typhoid was traced to the city water supply during this period, although many epidemics of dysentery occurred prior to the adoption of free residual chlorination. There has not been a single outbreak since.

Increased Pollution

Prior to 1913 the Ohio River was a source of fish for the people living along its banks. Today the only fish in evidence are a few carp and a few

small catfish, and these are found at the mouths of the sewers. Swimming in the Ohio River was once a popular sport, but after 1934 it lost its appeal because most of the swimmers became infected with skin diseases which were difficult to cure. Boating has likewise practically disappeared, as a result of the periodic stench.

The raw water, as taken from the river at Wheeling, has varied from good to very bad, with all the stages in between. Likewise, the water turned out has varied from excellent to extremely vile smelling.

The amount of chlorine found necessary to produce an 0.1-ppm. residual serves as an excellent yardstick to measure the degree of pollution from year to year. The records show that a feed of 1½ lb. per million gallons (0.17 ppm.) was required in 1918, 2½ lb. (0.3 ppm.) in 1925, 4 lb. (0.48 ppm.) in 1933, 8 lb. (0.96 ppm.) in 1939, 14 lb. (1.7 ppm.) in 1944 and 20 lb. (2.4 ppm.) in 1949. The records for free residual chlorination go back only to 1940, but they too show the rapidly increasing pollution. The average chlorine feed rose from 36 lb. per million gallons (4.3 ppm.) in 1940 to 111 lb. (13.3 ppm.) in 1947. Using chlorine dioxide, the feed was 106 lb. (12.7 ppm.) in 1948 and 81.5 lb. (9.8 ppm.) in 1949.

In 1949 the coliform count ranged from 10,000 to 100,000 per 100 ml.; dissolved oxygen, from 2 to 10.6 ppm.; B.O.D., from 1.8 to 13.5 ppm.; manganese, from 0.2 to 4.0 ppm.; phenol, from 0 to 400 parts per billion, averaging 25.0; and pH, from 4.2 to 7.2.

Cost of Treatment

To meet the ever increasing degree of pollution, it has been necessary to

modify or change the method of purifying the water on an average of every two years, as shown in Table 1. Not only does treatment require more chemicals from year to year but the costs of the chemicals are rising as well. The indiscriminate use of rivers as an outlet for wastes is forcing the water plants to carry much too big a burden.

Carefully maintained records show that domestic sewage from cities above

industrial pollution, making a total of \$59.

Enormous quantities of acid pickle wastes are dumped daily into the supply sources. Continuous-strip mills contribute as much as 200,000 gal. of 20 per cent sulfuric acid daily. It is a fair estimate that 1 mil.gal. of waste pickle liquor reaches the Ohio River each day, requiring 2 bil.gal. of water per day with 100 ppm. total alkalinity

TABLE 1
Types and Costs of Treatment

Date	Purification Process Used	Chemical Costs \$/mil.gal.
1814-1918	None	0
1918-1925	Chlorine	.15
1925-1934	Alum, lime and chlorine	2.25
1935	Ferrous sulfate, chlorine-ammonia	2.43
1936	Ferrous sulfate, lime, prechlorination, postchlorination, ammonia	2.78
1937-1939	Same as 1936, but including various quantities of carbon fed at various points	2.53
1940-1942	Ferrous sulfate and lime, free residual chlorination,* carbon	2.89
1943	Ferrous sulfate, lime, free residual chlorination, aeration	3.21
1944	Superchlorination, split-lime treatment, aeration, carbon, addition of 10% well water, dechlorination with sulfur dioxide	6.58
1945-1947	Same as 1944, except sodium bisulfite used as dechlorinating agent	6.50
1948-April 1950	Ferrous sulfate, split-lime treatment, free residual chlorination plus 3 ppm. chlorine, diffuser type aeration, chlorine dioxide and caustic soda for pH adjustment, carbon if and when needed	7.75
Future	Next modification of treatment to meet future increased pollution will be substitution of caustic soda for lime	

* Finished water has carried a 1.33-ppm. free chlorine residual or higher since September 1940.

Wheeling is responsible for 33.7 per cent of the plant expenditures for purification chemicals, while 43.1 per cent is attributed to industrial wastes. The balance of 23.2 per cent would represent the entire cost if there were no pollution present. Translated into dollars and cents, Wheeling must pay out an average of \$27 per day on account of sewage pollution in its source of supply and \$32 per day on account of

even to neutralize it. Since the Monongahela River, which makes up about 50 per cent of the Ohio, is already acid from abandoned coal mine drainage, it is understandable that the Ohio River, although 1,200 ft. wide and 15 ft. deep, contains free sulfuric acid on an average of three months in the year.

Experience during the last two years of the war, when industries were work-

ing three shifts, proved that there is a definite limit to the amount of domestic sewage, coke oven wastes, sulfuric acid and the like which can be permitted in a source of water supply. Beyond that limit, it is impossible to turn out a palatable water, regardless of the amount of purification chemicals used.

The future seems to offer only two alternatives. One is to stop the loath-

some habit of dumping untreated domestic sewage and industrial wastes into the sources of water supply. The other alternative is to build huge reservoirs, at great cost, to store as much as a 30 days' supply of superchlorinated and chlorine dioxide-treated water, which can be held for further improvement by intense aeration and exposure to sunlight.

Brantford, Ont.—Donald B. Williams

As a preface to statements concerning the Brantford, Ont., situation, the author would like to offer his opinion on what might be considered suitable treatment for an unpolluted stream, as opposed to that for a polluted stream of the same general nature and geographical location.

For the unpolluted stream, minimum doses of coagulant on the order of 9-17 ppm. might well suffice. Natural tastes and odors resulting from seasonal changes, such as the falling of leaves, might require activated carbon dosages up to 2 ppm. Chlorination dosage, a sharp index of stream characteristics, used on such a reasonably safe water purely as a safeguard, might reach a maximum of 0.5 ppm. A water in this class could be treated in what is commonly called a "textbook plant."

If coagulants are used in larger amounts for the coagulation of suspended matter and the precipitation of soluble organic substances; if carbon is needed in greater quantities; if chlorine is required for any purpose other than to guarantee safety, such as for color removal, oxidation of tastes, odors and organic matter, and aiding in coagulation; if chlorine dioxide, ozone, sulfur dioxide, ammonia or any special combination of these and other treat-

ments is required; and if specialized design and appurtenances are necessary—for example, aerators or abnormally long contact periods for chlorine and other treatments—then the plant is dealing with a polluted stream.

Even in a plant having no laboratory, and with no analyses of the raw water being made, the gradual stepping up of these processes, particularly the carbon and chlorine dosages, can be taken as an indication of increasing pollution. There may be some disagreement on what constitutes maximum treatment for an unpolluted stream but it is felt that this opinion will meet general acceptance.

Furthermore, it is suggested that pollution refers to those substances in a water which are not natural constituents during its primeval state and must be removed or treated to produce a safe, acceptable product. Such substances include all sewage, the wastes from any industrial endeavor, the drainage of agricultural fertilizers and insecticides, high turbidity due to poor soil conservation, high plankton incidence (resulting from the nourishment of such forms of life by sewage and low warm-water conditions caused by a lack of conservation on the watershed), all man-derived bacteria and

viruses, and any other substances entering the water or generated therein due to the agency of man.

It should be realized that a plant may be heavily overloaded in one direction and yet not in another. Seasonal and other changes might reverse conditions, often producing two or more types of overloading coincidentally. At Brantford, for example, an ice-covered river produces high free ammonia, high odor and a high chlorine demand with almost zero turbidity. A winter flood produces opposite effects. Late summer brings low turbidity, high plankton incidence, high odor, zero free ammonia and a below-average chlorine demand but one in which contact time is of greater importance because of the high protein content. The term "pollution loading" can, therefore, not be restricted to a single meaning.

Brantford Adjustment

Prior to 1931 all raw water at Brantford was derived from a collecting-gallery system. No filtration was employed. As a safety factor only, marginal chlorination was practiced, using chloride of lime in the early years and, later, chlorine gas. A very acceptable water was produced, except in the gallery cleaning period.

Just before 1931 increased consumption overtaxed the capacity of the galleries and it was not found feasible to extend them. Consequently, in 1931 a 5-mgd. (Imp.) rapid sand filter plant was put into operation to treat the existing gallery water and to draw on the Grand River for additional supply.

From 1931 to 1945 the chemical treatment may be summarized by stating that rarely did the alum dose exceed 7 ppm., that it is doubtful whether the total of pre- and postchlorination doses ever exceeded 1 ppm. and that

only on rare occasions was activated carbon used to the extent of 0.5 ppm. No laboratory existed, only two simple color tests being made daily for the presence of chlorine. Therefore no clue to the condition of the river during this period exists other than a slight seasonal fluctuation in chlorine demand. Although these minimal treatments produced a generally satisfactory water during the period, latter years were marked by the occasional delivery of highly turbid water and the increasing presence of musty tastes in the finished water, which seemed to escape general notice. Other than for alum, the only chemical feeding equipment consisted of two 40-lb.-per-day chlorinators and one 300-lb.-per-day carbon machine.

Early in 1946 phenolic tastes resulted in a public outcry. This condition was successfully treated with chlorine dioxide, but later intense algal tastes, not removed by chlorine dioxide, again caused unfavorable public opinion. Investigation indicated an increasingly polluted river and the necessity for increasing plant capacity on both a volume and chemical treatment basis. The consulting engineers recommended the installation of a laboratory to study river conditions and to find suitable treatments. With the exception of phenols, the summer of 1947 was a duplicate of 1946. The absence of a laboratory and the low capacity of existing chemical equipment precluded any improvement of treatment.

The laboratory put into operation in September 1947 soon indicated free residual chlorination to be the best all-around procedure for reducing tastes and odors in the water from the existing plant. This process, started in November 1947, required the replacement of two old 40-lb. chlorinators

with two 400-lb. machines. Originally chlorination to breakpoint was attempted, but several factors made it necessary to chlorinate to considerably above this point, requiring dechlorination by sulfur dioxide, and, hence, the installation of two 400-lb. sulfonators.

In 1948 high-level free residual chlorination controlled by dechlorination resulted in a marked improvement over previous conditions. Even the algal tastes and odors, although not completely removed, were much reduced and far less objectionable in nature. The use of up to 15 ppm. activated carbon to remove algal tastes and odors was indicated, but, because of prevailing filter rates and poor coagulation facilities, any dosage in excess of 2 ppm. produced black water. Nitrogen trichloride formed by reactions between chlorine and nitrogenous substances in the water proved troublesome but was overcome in November 1948 by the application of a special procedure requiring the installation of a 35-lb. ammoniator and a 50-lb. post-chlorinator (1, 2).

Free residual chlorination with its attendant adjustment procedures has continued to produce a product superior to 1946-47. It has been possible to maintain complaints at a minimum while making a study of pollution loading in its several aspects, as well as the treatment processes indicated, prior to enlarging the plant capacity to 7.5 mgd. (Imp.).

Future Needs

Assuming the continuance of present pollutional loads with the above-mentioned plant expansion soon to take place, laboratory and plant investigation has indicated the following requirements:

1. Improved coagulation facilities, including the use of activated silica, to offset high turbidity and to permit greater dosages of carbon.

2. Combined residual chlorination through the filters, requiring a chlorinator of 400-lb. maximum capacity.

3. Free residual chlorination following filtration, requiring a 2,000-lb. chlorinator.

4. Continued use of the two 400-lb. sulfonators.

5. Continued use of the 35-lb. ammoniator and an increase in post-chlorinator capacity from 50 to 100 lb.

6. Installation of chlorine residual recorders for better control of these operations.

7. Installation of carbon feeding capacity up to 3,000 lb. per day.

This list comprises only the bare essentials and does not include duplicate equipment to offset breakdown and maintenance periods.

With the expansion to 7.5 mgd. (Imp.), if there should be greatly increased pollution, it will be advisable to adopt the excess-lime process (together with necessary adjustments) to remove much of the organic material prior to applying present and proposed treatments.

It is evident that the Brantford plant has come a long way from the simple, minimal treatments of nineteen years ago to the present high-rate chemical treatment of a fairly complicated nature, which may have to be further expanded and supplemented in the future.

References

1. WILLIAMS, D. B. Solving a Difficult Taste and Odor Problem at Brantford, Ontario. *Wtr. & Sew. (Can.)*, p. 17 (June 1949).
2. ———. A New Method of Odor Control. *Jour. A.W.W.A.*, 41:441 (May 1949).

Evaluation of Stream Pollution

By L. L. Hedgepeth

A paper presented on May 24, 1950, at the Annual Conference, Philadelphia, by L. L. Hedgepeth, Technical Consultant, American Cyanamid Co., Bound Brook, N.J.

IT has been well said that a measure of stream pollution is a necessary incident to modern life and that compensation is to be found in the arts and sciences of civilization. Despite the logic of this observation, when one reflects on the considerable record of stream degradation in the United States, the burden it is imposing on the nation's economy and the threat it presents to health and happiness, it becomes evident that manmade abuse of natural waters has often exceeded that which is an unavoidable result of the American way of living. As a result of this conclusion's being reached by a large portion of the people, including many of those whose interests have added to the pollution problem, stream pollution is being placed under legal controls of the state and federal governments.

Broadly stated, the nation has decided to require that its natural waters be used without abuse. This resolves into being good neighbors and avoiding unreasonable encroachment on the rights of others, a well settled principle which was beautifully stated by the Minnesota Supreme Court (1) in an air pollution case:

We are not disposed to adopt any rule which will hamper the development of natural resources of the state, but in their development reasonable regard must be

had for the health and comfort of the people living in the neighborhood.

and, more recently, by Millar (2):

The success of our efforts in stream pollution work must be judged by the degree to which our neighbors and the public accept the results of our program. Public acceptance is actually the "proof of the pudding" insofar as waste disposal work is concerned.

Control of Pollution

Reduced to its simplest technical terms, the problem in stream pollution control is to protect the presently clean waters and to improve the unclean waters. Because much municipal and industrial development has included no treatment of sewerage wastes, the realization of the control program has not been so simple. Its successful achievement requires a measuring and balancing of all interests in order that the economy may become adjusted, without shock, to the required changes.

In reviewing the postwar developments in pollution abatement, the author's first conclusion was that this is not a penny-ante game. The stakes are so large that there must be no question about the necessity for the abatement being requested all over the country. If there is any doubt about it, few municipalities or industries will be able to justify the heavy investments

needed and to assume the considerable operating costs involved. Nothing short of an absolute requirement to abate stream pollution will do the job. And this requirement must be equitably applied.

There has been an unprecedented rise in the costs of sewage and industrial waste treatment. Wolman (3) estimates that costs have increased four- to fivefold since 1942 when Schroepfer (4) gave construction costs for sewage treatment as \$3.00 to \$12.00 per capita. It is sobering to think of the impact of these costs on the economy of many smaller communities where the expense of required sewage treatment will be heavy in proportion to the ratables on the tax books.

A similar situation exists in the disposal of industrial wastes. In Virginia, three-quarters of a million dollars in construction costs and one-third of a million in annual operating costs comprised the bill for the treatment of the chemical wastes from one plant. In another, the construction costs were two-thirds of a million, with an unrevealed but obviously quite heavy operating cost for meeting the sane and simple requirement that presently clean waters must remain clean. Spread all over an industry or a section of the country, these are big stakes, and the costs of pollution abatement are evidently going to be so great that it is silly and wishful thinking to expect this job to be done unless it is made mandatory and its costs sensibly determined and equitably applied.

Second, the concepts of pollution and suitable treatment should be critically examined in order to determine whether pollution and the need for the required treatment can be established for each stream user to the satisfaction of the

public. Obviously, actual abatement of pollution may be secured only through abatement of the individual contributions. It was because of the necessity of proving each individual case that the author (5) in 1946 proposed to the Association the term "too much" as a realistic and adequate definition of pollution. Later, in 1949, he (6) suggested that forcing this matter into standards was unworkable and that each situation should be appraised on its merits.

It is apparent that, until pollution can be measured with sufficient accuracy to differentiate between its various factors, it will not be possible to fix the separate responsibilities of each polluter with blanket orders. This is a form of previous restraint which is contrary to the American way of thinking and may discredit this worthy enterprise of providing for the safety and health of the people by the protection and restoration of the streams.

Unsewered Pollution Sources

In addition to the industrial wastes and the untreated sanitary sewage causing the difficulties under which water plants are operating, acid mine waste is a problem to be reckoned with in several major river basins. In the opinion of the Advisory Committee on Water Pollution (7), the total acid load from mine drainage in 1939 was 2,700,000 tons daily for all of the United States east of the Mississippi. Of this, 375,000 tons had been removed through mine sealing, with an additional 600,000 tons to be removed by the program then under way. Subsequently, the feeling has grown that mine sealing, by itself, is not enough to solve this problem; and the Pennsylvania Sanitary Water Board has set up

a separate and special program of attack. The author has no direct information on these later developments.*

The seriousness of the silt load does not enter into this discussion, but it is an important stream pollution factor, as was pointed out in 1949 by Kemp (9). The consensus of professionals in the field is that silting may be best controlled through education of landowners in accepted methods of reforestation, land use and catch basin installation.

Use of Assimilation Resources

Much is made of the right to use the assimilation resources of the stream for the disposal of municipal and industrial wastes. This plea is usually the theme of efforts to find common ground in this field of conflicting interests. Whether a given discharge is a use or an abuse of a stream usually turns on the question of whether the use is reasonable under all of the circumstances. No hard and fast rule controls the subject, since a discharge which would be a reasonable use under one set of conditions would be abuse under another. And the letter of the law, or regulations issued under authority of the law, do not necessarily control the securing of actual abatement, although they do control official utterances. For, when a given stream condition is the result of numerous and complicated circumstances, the facts rather than the law must be of the greater importance in arriving at a workable and equitable solution. Because of the complications of stream pollution, particularly industrial pollution, it is beyond the scope of human

ingenuity to devise a precise expression of what is or is not pollution under all conditions.

It is relatively simple to express limiting concentrations of undesirable substances in a stream by applying safety factors to published data and issuing the results under the authority of the law. It is an entirely different matter to police or conform conscientiously to such requirements unless they are specifically applicable. On the other hand, when technical intelligence and work are applied to complex stream pollution problems, workable and effective limitations may be precisely stated.

This fact has recently been well demonstrated by Renn and Brastow (10) in determining safe assimilation levels of zinc in the Shenandoah River. A very considerable amount of highly specialized manufacturing and stream sanitation knowledge was necessary to define the problem accurately. Factors peculiar to that stream and its types of pollution were found to have important effects on the safe levels of zinc downstream. It is doubtful if these findings are valid for other situations without critical reappraisal under each new set of conditions.

Changing Problems

The technical nature of industrial pollution is not constant. In order to avoid obsolescence, and to keep pace with progress, industry—particularly the chemical industry—is continually changing its processes. Older stream pollution problems disappear only to be replaced by new and different ones for which there is no directly comparable previous experience.

For example, *Chemical Engineering* (11) very recently published a list and discussion of new synthetic fibers en-

* A description of the Pennsylvania clean-streams program appeared in the January 1950 JOURNAL (8).—Ed.

tering, or about to enter, the textile market. The production estimates are considerable. Thus, the comfortable feeling of stream pollution workers that at long last the rayon problem was well tagged may be an illusion. New evaluations of presently unknown factors must be the certain result. The antibiotic picture is changing. So are the pigments, the dyestuffs and many other classes of industrial products.

Missing Yardsticks

Imaginative reasoning will be needed in the solution of these problems.

There is no universally applicable yardstick for measuring stream pollution. This conclusion, reached in 1939 by the Special Advisory Committee on Water Pollution (7), is valid today. In view of this deficiency, one is puzzled by the official estimates of the problem. The latest coming to the author's attention stated the problem in September 1949 as being the wastes of 50,000,000 people in addition to industrial wastes with a population equivalent of 90,000,000. One might at this point inelegantly observe that, since there is no method of universal measurement, there can be no universal measurement.

The customary common denominator, biochemical oxygen demand, may be used on industrial wastes only by forcing the fit. And forced fits, as every skilled mechanic knows, are never good workmanship and are seldom safe. There is a growing feeling among industrial-waste workers that the corollary term, "population equivalent," is a hybrid of doubtful parentage and of nonspecific application. They ask why industry should accept this classification. There are no fecal organisms or human refuse in industrial wastes, nor

does domestic sewage contain significant quantities of industry's acids, alkalies, phenols or toxicants. The problems are not the same.

For example, 167 lb. of waste acetic acid is not the population equivalent of the daily wastes of 600 people, even though, under standard testing conditions, the five-day B.O.D.'s are the same. The effects on the stream and the assimilation rates are quite different, as was demonstrated in 1948 by a cooperative and intensive study of the South River below Waynesboro, Va. (12). This term has little to be said in its defense, except that it permits easy, if inaccurate, cataloging for convenience of the adding-machine mind.

The new bioassay techniques, such as are being advocated by Roberts and Patrick (13) largely to replace the chemical and physical methods previously employed, offer considerable hope for the development of more reliable methods of measurement of *overall pollution effects*, or of the establishment of the health status of a stream *before* a new discharge is commenced. But they offer little hope of improvement in methods for differentiating the causes of stream degradation. Lackey (14), in 1949, pointed out the fact, confirmed by other stream pollution biologists, that there are no specific biological indicators of pollution. Diagnosis depends upon general symptoms. It would appear that this new device has much value in determining whether the patient is ill but is of little promise in diagnosing the causes of the disease.

Nor will the customary measurements of the chemist be in themselves sufficient. For example, Galtsoff and his collaborators (15), in reporting on the causes of the injury to oysters in

the York River in Virginia, stated that there is no chemical test for the detection and quantitative determination of pulp mill wastes in natural waters. In drawing their involved conclusions, they relied largely on a mass of presumptive evidence collected over a 30-year period of study.

The conclusion is inescapable that, in making a determination of the effects of pollutants on the stream, considerable specific experience and mental alertness are needed. Illustrations are abundant. Catlett (16), in writing recently on textile wastes, warns:

The necessity for caution in interpretation cannot be too strongly emphasized. For example, wastes from the vat dyeing of cloth in a padder cannot be compared with vat dye wastes from chain warp. . . . You cannot compare wastes from black dyeing with those of pastel shades.

And Wolman (3), in calling attention to some of the blind reasoning being employed in regulating stream pollution, observed:

The hold which stream criteria have upon professional and lay workers in this field is sometimes astonishing. The slide rule and the mathematical devices have begun to force out of consideration critical appraisals of stream pollution abatement decisions.

Lessening of Load

Concluding, then, that civilization has determined to bring stream pollution under control, that it must be prepared for the considerable costs of the program, that the know-how for the adequate treatment of sanitary sewage is available, that there is much to learn about industrial wastes before the job can be done and that an evangelized scientific approach is needed to cope

with the industrial pollution problem—what relief is in sight for the harassed water works operator whose job it is to convert industrially polluted water into a sparkling and pleasant drink?

A great deal is being done—enough to warrant optimism—and much more than appears in the record. Management of leading industries has determined that, as a matter of fundamental policy, stream pollution prevention will be an integral part of all new or expanded plants, or new processes, and that the attack on existing pollution must be continued until a satisfactory solution is found. As a result, many of the new plants or expansions erected during the past few years have waste prevention or waste treatment included in the original construction.

In addition to this basic policy, the technical men of industry are using their special skills and process knowledge in pressing new attacks on the problems of existing pollution. The results are frequently satisfying and are sometimes phenomenal. For example, methods have recently been reported for the adequate treatment of viscose rayon wastes, by Renn and Brastow (9); for antibiotic wastes, by Muss (17) and Hilgart (18); for formaldehyde, by Dickerson (19); and for mixed wool scouring and dyeing wastes, by Coburn (20). Thus, the pollutional threat of industry is being removed through the only route known to the author as being effective—that is, by a cooperative pooling of special skills of industry, of government and of the professional men who are devoted to this science.

Stream pollution abatement knowledge, developed at great cost and effort, is being freely exchanged at heavily attended and unpublicized conferences

of industry. The earnestness of these meetings furnishes assurance that industry is constructively getting at its complex problems. It is a good quality of free people to meet and criticize their own actions—to look over the course they are following and to be asking whether it is effective and proper. This is much better than to be asking government to solve family problems. The author believes that if those concerned choose to be brave and mentally alert, there is justification for believing that the job can be done.

References

1. *Brade v. Minnesota Crushed Stone Co.* 143 Minnesota 374, 173 N.W., 805, 6 A.L.R. 1092 (1919).
2. MILLAR, J. N. Cooperating With the Community. *Compilation of papers presented at Mfg. Chemists' Assn. Water Pollution Abatement Conf.*, Feb. 9-10, 1950.
3. WOLMAN, ABEL. Bacterial Standards for Natural Waters. *Sew. & Ind. Wastes*, 22:346 (March 1950).
4. SCHROEPFER, G. An Analysis of Stream Pollution and Stream Standards. *Sew. Wks. J.*, 14:1030 (Sept. 1942).
5. HEDGEPEETH, L. L. Industrial Use of Streams. *Jour. A.W.W.A.*, 36:532 (June 1947).
6. ———. Stream Standards, A Critical Discussion. *Lecture at In-Service Training Course in Sewage and Industrial Waste Disposal, School of Public Health, Univ. of Michigan March 14, 1949.*
7. Water Pollution in the United States 3rd Rept. of the Special Advisory Committee on Water Pollution. House Doc. 155, 76 Cong. 1 (1939).
8. MOSES, H. E. Pennsylvania's Clean Streams Program. *Jour. A.W.W.A.*, 42:146 (Jan. 1950).
9. KEMP, H. A. Soil Pollution in the Potomac River Basin. *Jour. A.W.W.A.*, 41:792 (Sept. 1949).
10. RENN, CHARLES E. & BRASTOW, THOMAS. *Papers on cleaning up Shenandoah River pollution, presented at meeting of Virginia Industrial Wastes and Sewage Works Assn., March 30, 1950.*
11. Staff Report on New Synthetic Fibers. *Chem. Eng.*, 52:3:114 (March 1950).
12. South River Pollution. Staff Report. Virginia Water Control Board (Nov. 1948).
13. ROBERTS, H. RADCLIFFER & PATRICK, RUTH. Biological Determination of Stream Pollution. *Presented at Mfg. Chemists' Assn. Water Pollution Abatement Conf.*, Feb. 9-10, 1950.
14. LACKEN, JAMES B. Use of Biological Indicators in the Determination of Stream Pollution. *Lecture at In-Service Training Course in Sewage and Industrial Waste Disposal, School of Public Health, Univ. of Michigan, March 14, 1949.*
15. GALTSOFF, PAUL S., ET AL. Ecological and Physiological Studies on the Effect of Sulfate Pulp Mill Wastes on Oysters in the York River, Virginia. U.S. Fish and Wildlife Service Fishery Bul. 43 (1947).
16. CATLETT, GEORGE F. Textile Wastes as Related to Stream Pollution. North Carolina State Stream Sanitation and Conservation Committee (1948).
17. MUSS, DAVID. Handling of Antibiotic Wastes. *Presented at Mfg. Chemists' Assn. Water Pollution Abatement Conf.*, Feb. 9-10, 1950.
18. HILGART, A. A. Design and Operation of a Treatment Plant for Penicillin and Streptomycin Wastes. *Sew. & Ind. Wastes*, 22:207 (Feb. 1950).
19. DICKERSON, H. W. High-Rate Trickling Filter on Formaldehyde Wastes. *Sew. & Ind. Wastes*, 22:536 (April 1950).
20. COBURN, STEPHEN. Modern Wastes Treatment Plant. *Wtr. & Sew. Wks.*, 97:167 (April 1950).

Pollution Control and Property Rights

By John H. Murdoch Jr.

A paper presented on May 24, 1950, at the Annual Conference, Philadelphia, by John H. Murdoch Jr., Vice-Pres. & Counsel, American Water Works Service Co., Inc., Philadelphia.

IT appears to the author that the simplest way to make clear his thoughts on pollution control and property rights is to set up a hypothetical but typical set of facts and then to explain the legal principles involved through a discussion of the conflicts of interests revealed in the assumed situation. Stream pollution and pollution control do create conflicts of interests which must be understood and determined. For this purpose the lawyer is needed, if only rarely welcomed.

The total land area drained by "Somewhere Creek" is 500 square miles. The population is about 50,000, of whom 35,000 live and work in the county seat at the mouth of the creek where it joins a large river. The remainder are about equally divided between farms in the broad bottom lands bordering the creek and its branches, and the mining and manufacturing villages along the streams above the county seat (see Fig. 1).

One of the mining villages belongs to the Ancient Coal Co., which owns 1,000 acres of unmined coal out of an original holding in the valley of about 3,000 acres. A second mine has just been opened by the New Strip Mining Co. This mine is upstream from the Ancient mine and above the water supply intake and filtration works of the Ancient Coal Co. village. Both mines are for the development of a

high-sulfur vein of coal which naturally drains into Somewhere Creek, the only possible source of water supply for the various communities along its banks, including the county seat. The farmers in the valley use the creek water for domestic purposes and for stock watering. A rayon plant has recently been established on a branch of the creek which joins the main stream above the county seat but downstream from the Ancient mine. A chemical plant, an oil refinery and a steel mill are beginning to operate on a second branch similarly located with reference to the county seat. Below the county seat and the mouth of Somewhere Creek, there are several large communities depending on the river for water and recreation.

Acid mine water has been drained from the Ancient mine for a number of years, but the dilution in the creek has been such that no very serious harm was done to the water supply of the county seat. Farmers and fishermen were affected, however. The opening of the new mine and the extension of the Ancient mine have added such a load of acid mine water as to make adequate dilution impossible except at times of high water. The rayon, chemical, oil refinery and steel plants have now added new pollution to the creek above the county seat water works. The county seat empties

raw sewage into the river below the town. Oil wells in the valley of Somewhere Creek pump salt water into the watershed, and the farmers draw good royalty payments from their owners. Everyone in the valley is engaged in a socially desirable business. The water of Somewhere Creek has such a high pollution load of industrial, mine and oil well wastes as to render it unfit for public water supply. The health and safety of the public in the county seat are endangered, while the raw sewage of that town endangers those drawing water from the river.

Legal Relationships

Such are the essential physical facts in this typical situation. Now consider some of the legal relationships in the situation. The Ancient Coal Co., having legal title to its acreage, has a property right in the coal—that is, it has the right to be unmolested in its possession and the right to remove the coal and ship it away for sale. It has the right to retain its coal even against the state—assuming it pays its taxes—unless the state takes the coal under the power of eminent domain and pays full value for the property. In the same way, the New Strip Mining Co., the rayon, steel, oil refinery and chemical companies have legally protected property rights in their land and its resources. Others owe them the duty of respecting those rights. The farmers have property rights in their farm lands and in the oil underlying them and—at least under common law—the right to a reasonable use of the water in the creek, unpolluted and undiminished in quantity.

In the enjoyment of these property rights, various owners have harmed other owners or the public, resulting in

a different set of legal relationships. The Ancient Coal Co. has polluted the creek with acid mine drainage and has rendered it unfit for watering livestock. In some states, such an invasion of the rights of others could be enjoined or would entitle the injured party to damages. In others, the great social benefits from the development of the natural resources might be held to outweigh the inconvenience to the one harmed, and the mine operator would have a privilege to continue. That is, he would have a mere freedom from legal restraint on his conduct at the instance of the private person harmed, but such freedom, not being founded upon a grant, is not a property right.

The New Strip Mining Co. puts acid mine drainage into the stream above the water supply works for the mine village of the Ancient Coal Co. Thus, one who has already harmed others by similar conduct now becomes the victim and the public suffers through bad water. Moreover, the New Strip Co., by adding its acid mine drainage to that already being put into the creek by the Ancient Co., so overloads the stream as to render the water unfit for use at the county seat. Under these circumstances is the New Strip Mining Co. solely to blame? Perhaps it could prove that its drainage would not endanger the people of the town if the Ancient Coal Co. were not also putting acid into the creek. In a contest between the two the outcome might be in doubt.

Further complications enter the situation when the pollution from the new works on the branches is considered. Each plant could prove, perhaps, that its industrial wastes alone would do no substantial damage to anyone. Yet every added source of pollution multi-

plies the physical, chemical and biological difficulties of the public in the county seat.

The people of that community are the innocent sufferers from the contamination of Somewhere Creek above their town, but, on the other hand, their community is making life burdensome for the inhabitants of the valley of the river below them, who suffer because of the sewage contamination. Where are the equities there?

The farmers who suffer from the acid mine water drainage upstream draw royalties from oil wells on their

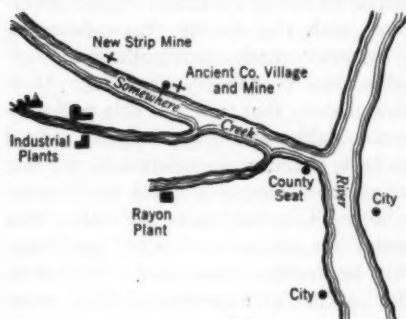


Fig. 1. "Somewhere Creek" Watershed

land which produce salt water that flows into the creek causing discomfort to those below.

The mines, the oil well operators, the manufacturers and the town are conducting their affairs in what each considers the way most advantageous to it. Each would suffer in profits or in capital investment if it operated so as not to harm others. The actual value of the property rights held by each would be lessened if the owner were required to give up the practices which cause the pollution.

Although the practices of each contribute to an end result which is injuri-

ous to the public, the extent and nature of the individual contribution to that end result might be very difficult to prove. The advantages of the development of the natural resources and the industrialization, and the rising living standards in the valley resulting from the activities mentioned, might well have the effect of making the conduct privileged as against other individuals or corporations.

Legal Remedy

The essential fact in the entire complicated situation is that the health and safety of the public are endangered because of the pollution of the source of water supply. Once that fact is established and recognized, the resulting legal relationships become relatively clear and uncomplicated. The industries and the communities in the valley have, by the complicated interplay of their various activities, endangered the public health and safety. Acting as individuals but within a common framework of circumstances, each has contributed to this final result. The result is an offense against the state, an inconvenience and danger which annoys and threatens the whole community and not merely some particular person. It is a public nuisance, which may be abated at the instance of the state without the payment of any compensation to those whose actions are regulated. No one can have a property right to commit or maintain a public nuisance, and the state can be required to pay compensation only when property rights are taken away.

An inalienable right of a state is the exercise of the police power. It is the duty of a state to protect the health and safety of its inhabitants, and its acts in so doing are performed under the

police power. When acting in the reasonable exercise of the police power, the state is not required to pay compensation to those whose interests are adversely affected. Property is not taken by the state under the police power, even though its value in use may be materially lessened. When property itself is required by the state, it may be taken from its owners by the power of eminent domain and the owners must be compensated. But the exercise of the police power for the protection of the public is not an exercise of the right of eminent domain.

It is evident, therefore, that in a situation like Somewhere Creek, the public is neither powerless nor faced with the need to expend public money to acquire property rights. Those who are polluting the public water supply have no property right entitling them to continue such pollution. The state, through the exercise of its police power, can prohibit all pollution without the payment of any damages, although much money loss would be entailed. The only question is the extent to which the legislative branch of the government wishes to go in authorizing the use of the police power. It is for the legislature to fix the standards and the limits of permissible pollution. It must weigh the social advantages of land use and industrial development against the public need for satisfactory water in ever increasing quantities. The legislature should strike the bal-

ance in the form of a general law to be enforced wherever applicable. That is the American way. Unless the legislation is clearly unreasonable, it will be constitutional and will be upheld by the courts.

Conclusion

Water works officials should have hope and courage regarding pollution control. The thinking of industrial leaders, public officials and the general public has changed rapidly in very recent years. The former attitude of acquiescence in unlimited stream pollution, with the feeling that advancing civilization made such pollution inevitable, has completely changed. It is now known that much of this pollution is avoidable, and there is good reason to hope that the scientists will yet find ways to eliminate a great deal more. The public is beginning to realize that water resources are limited and must not be further destroyed. Yet it is the author's experience that, even today, those whose interests are hurt by necessary and reasonable stream pollution controls feel that their property rights are being invaded. Responsible officials must have the courage to point out unpleasant facts and, in the public interest, must often maintain unpopular positions.

The law will help in stream pollution control if water works officials are alert and have courage.

Cost of Refrigerative and Other Special Service

By Elwood L. Bean

A paper presented on May 26, 1950, at the Annual Conference, Philadelphia, by Elwood L. Bean, Prin. Asst. Engr., Bureau of Water, Philadelphia.

AMPLE water supply is utterly essential to innumerable industries which are the very foundation of the present-day economic system. It is likewise essential to the operation of many machines which contribute to everyday living, health, comfort and pleasure.

Frequently expanded use of available equipment is hampered, for the production and sales fields, by limitations inherent in the design of existing buildings with regard to equipment space, piping channels, electrical conductors and similar items. Similarly, in the public utility field, expansion of service as desired is frequently hampered by the amount of investment and time required to accomplish the tremendous changes needed to provide for continued uncontrolled increases in water usage.

The refrigerative and air-conditioning industries are not promoting luxuries. The use of such equipment is profitable for a community—its installation promotes the general welfare and encouraging its use is of interest to the utility, but such use must be encouraged in ways which will not jeopardize the present or future water supply.

There have been conflicts in viewpoints but there is no conflict of interest, when considered on a long-range basis, between the utility and the in-

dustries which desire to use more water. Engineers of the utilities, in communities representing more than 90 per cent of the total population served, are actually municipal officials and regard the welfare of their cities as their deepest concern. They know that an industry will not continue to flourish, or expand, unless it is good for the community in which it functions.

In issues of *Water Works Engineering* in 1930, there appeared several excellent articles pointing out ways of encouraging consumption, such as the use of the garden hose spray as an outdoor sport for youngsters, the sale of portable wading pools, advertisements to encourage beautiful lawns and even \$50 prizes for winners of "better lawns" contests.

In the twenty years since that time conditions have changed very greatly, and, although certain prominent engineers even today will advocate the encouragement of such items, it is rather generally recognized that loadings should be encouraged only when the load factor warrants the investments necessary to supply such service, or, in certain circumstances, when community development is at stake.

Tremendous quantities of water are used by various industries, as shown in Table 1, which indicates the relation between water consumption and indus-

trial production. Some of these industries will appear in the continuing growth of most cities, and, particularly in those classified as "industrial," they play a part in the normal increase in demand. Most frequently these industries: [1] are situated in the outskirts of the city; [2] have a definite, predictable loading concentration at one point; and [3] either secure their own water supply and provide their own means of waste disposal or contract with the city to assume a share of the costs of providing such major services. In certain municipalities, such as Balti-

TABLE 1
Water Use in Manufacturing

	Water Use gal.	Unit Produced
Rayon	16	100 lb.
Wool scouring	126	100 lb.
Oil refining	770	1 bbl.
Steel	65,000	1 ton
Paper	39,000	1 ton
Soda pulp	85,000	1 ton
Alcohol	100	1 gal.
Beer	470	1 bbl.
Electric power	80	1 kwhr.

more, Md., and Big Spring, Tex., sewage plant effluent is used by industry to reduce loading and costs of water supply.

There are other industries, however, which differ in that they: [1] are chiefly concentrated in the downtown or business districts; [2] have a demand which is spread, perhaps, but which is located in the high-demand section, where the water supply facilities are generally the oldest and are now the most inadequate; [3] because of this situation, cannot contract with the city, in the manner previously mentioned, to provide properly and equita-

bly for such service as is needed; and [4] have demand rates which are increasing much more rapidly than those of other industries and in many cities have probably already exceeded the total demands of such other industries as have been mentioned.

A very appropriate comment on the present-day situation in most water works appeared in 1948 in a magazine of the refrigerative industry: "It is not so much the total quantity of water available to a water works as the in-

TABLE 2
Mean Percentage Increase in Consumption

City	Mean Increase in Consumption Over Preceding Year—per cent			
	Avg.		Max. Day	
	1933-42	1943-48	1933-42	1943-48
Philadelphia	2.7*	3.0†	0.9*	5.1†
Detroit	1.6	4.6		
Providence	2.7	3.0		
Cleveland	3.0	5.0	3.9	4.8
New York	0.2	4.2		
Avg.	2.0	4.0		

* Reflects savings resulting from waste surveys and increased metering.

† May in part reflect increased pressures maintained in distribution system.

flexibility of existing water supply systems which makes difficult rapid changes in the amount of water available to any given locality. Once supply mains are put in place, modifying them becomes a major operation which can be undertaken only after much delay" (1).

Normal Water Use

In 1890 Turneaure and Russell found that water use averaged 90 gpd. per capita. Extensive data surveys (2, 3) have shown that by 1945 water

production had increased to 125 gpcd. (gallons per capita per day), an increase of 40 per cent. The number of consumers is also increasing each year; the rate of recent growth has been placed at 500,000 each year.

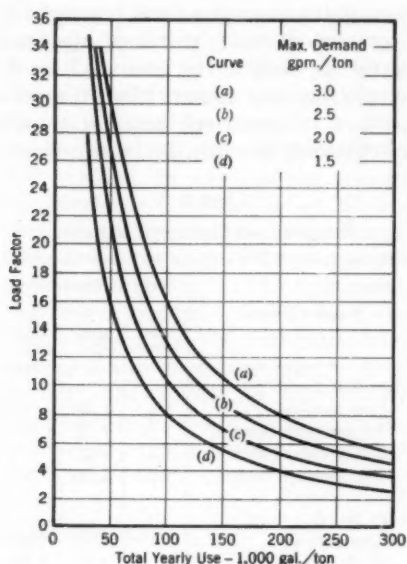


Fig. 1. Water Use and Load Factors of Unconserved Refrigerative Equipment

The combined result of these two factors has produced normal increases in system consumption which, averaged over decade periods, range all the way from nearly zero to more than 3 per cent a year, in recent years probably being most frequently in the vicinity of 2.5 per cent.

It is of interest to note that published (4) estimates for future use in New York City indicate a mean annual increase of 2.2 per cent. Also, in a 1949 survey published (5) by the American Public Works Assn., covering 27 water supplies, the estimated increases in consumption to 1960 would

equal an annual increase of 2.4 per cent above the previous year.

A study of the average water use in eight large cities from 1930 to 1948 shows that the heavy industrial consumption during the war is being maintained as the result of other uses since then, so that the upward trend in total

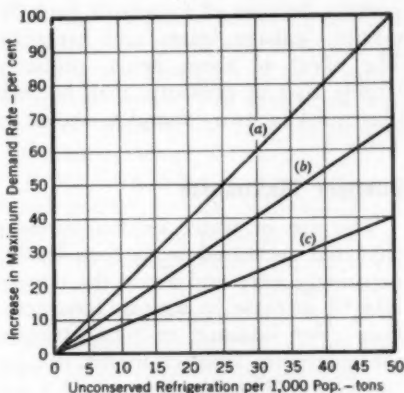


Fig. 2. Relation of Density of Unconserved Refrigeration to Increase in Demand Rate

The key to the curves shown is as follows:

(a) In terms of average consumption (125 gpcd., without refrigerative loading).

(b) In terms of maximum-day consumption (187.5 gpcd., without refrigerative loading).

(c) In terms of maximum-hour consumption (312.5 gpcd., without refrigerative loading).

use has been rather consistent since 1942.

The mean percentage increases in consumption in six water systems, in terms of the previous year's use, are shown in Table 2 for the ten years 1933-42 and also for the six years 1943-48.

In considering limited data involving

more than 100 water systems, the author has concluded that, for systems of medium pressure, the ratios of maximum consumption to yearly average are best represented by the following figures, which may be taken as medians: maximum month, 1.20; maximum day, 1.60; and maximum hour, 2.50. These ratios vary in different systems because of factors of load diversity, leakage losses and pressure. The effect of these items, probably largely that of pressure, may be well illustrated by two examples, shown in Table 3.

Summer Maximums

The use of water on hot summer days has increased by a considerable percentage over and above the normal rate of increase in average consumption. For instance, in New Orleans, the maximum summer month use for the years 1936-42 averaged 21.4 per cent above the March-May mean use, while in 1943-48 it was 27.2 per cent above the same mean, which represents a 27 per cent increase in the excess of summer day use over March-May average use. Similar figures on Detroit indicate a 15 per cent increase in the excess, while Philadelphia shows a 13 per cent increase. These excesses are on the upswing.

Refrigerative Load Factors

In contrast to the load factor ratios previously mentioned, Fig. 1 shows ratios of refrigerative loadings, with different rates of maximum demand and with variable total annual quantities of consumption. In those installations which use water only for summer cooling, the load factors for unconserved refrigerative machinery are generally poor, particularly so for air-

conditioning units in the more northerly sections of the country. Such units generally use in the zone of 60,000 to 80,000 gal. per ton per year, and the load factor is in the vicinity of 13. Installations for pure refrigeration, on the other hand, use three to four times as great a total, but without increased demand; therefore, the load factor is likely to be around 3 or 4. Neglecting any conservation, the proportion of pure refrigeration to air conditioning governs the factor, which,

TABLE 3
Pressures and Consumption Ratios

Pressure District	Ratio to Yearly Avg.		
	Max. Month	Max. Day	Max. Hour
<i>City No. 1</i>			
Low Service	1.12	1.30	
1st pressure district	1.14	1.35	
2nd pressure district	1.22	1.61	
3rd pressure district	1.22	1.76	
<i>City No. 2</i>			
Low service		1.35	2.15
High service		2.67	5.25

for a diversified area, is most likely to be in the zone of 9-11.

In this regard, it might be of interest to note that, for each five persons for whom air-conditioned space is provided, 1 ton of refrigeration is required. The quantity of water used by a 1-ton unit (unconserved) would be equal to the average household use of seven people. The maximum demand rate of this 1 ton, however, would equal the average household use of 90 persons.

Figure 2 shows the amount of increase in the maximum-hour demands which will result with different tonnages of unconserved refrigeration.

(The bases for the curves shown in the figure are consistent with data for the Philadelphia system.) Assuming an average per capita consumption of 125 gpd., a loading of refrigerative equipment equal to 70 per cent of capacity and a water demand of $0.7 \times 2.5 = 1.75$ gpm. per ton, then a refrigerative tonnage density of 50 tons (with unconserved use) per 1,000 population served would cause an increase in maximum-hour consumption (above consumption without such loading) of 100 per cent, in terms of the average consumption; an increase of 67 per cent of the maximum-day consumption; or 40 per cent of the maximum-hour consumption. (The maximum-day rate is assumed equal to 1.5 times the average, and the maximum-hour rate to 2.5 times the average.) Incidentally, the density of refrigerative equipment in Philadelphia and Chicago in 1949 was approximately 50 tons per 1,000 population.

Increased Use

Many consumption increases of considerable moment have been reported in recent years. For instance, according to annual reports, at Little Rock, Ark., the use in 1948 was 10.0 per cent above 1947, and, at Dubuque, Iowa, the use in 1948 was 8.2 per cent above 1947. At Minneapolis, Minn., the use in 1946 was 12.0 per cent above 1945. In 1949 Kansas City, Mo., reported a population increase of 10 per cent since 1940, while water consumption rose 30 per cent during the same period. The St. Louis County Water Co. had a peak hour of 48.5 mgd. in August 1948 and found it necessary to appeal to customers not to sprinkle from 3 to 9 P.M., to avoid approaching a calcu-

lated "disastrous" peak of 57 mgd. Trenton, N.J., has been filtering up to 36 mgd. through a plant designed for 30-mgd. capacity—an overload of 20 per cent. It is stated that, at the opposite side of the city, there is difficulty in obtaining enough water from the mains for normal operations. A Montreal, Que., newspaper reported in June 1949 that the public works department, because of a critical shortage, was demanding the cessation of lawn sprinkling, and police were sometimes used to force customers to shut off air-conditioning systems.

New York City is constructing a development for an additional 540 mgd., but, if the present rate of increase in consumption continues, the water supply will be inadequate, even when this development on the Delaware River is completed. The 1947 consumption was 85 per cent of the estimated total safe yield which will be available after completion of the project. Stringent regulations have recently been adopted. The Washington Suburban Sanitary Dist. adopted regulations limiting water use and disposal to the sewer system in 1948. These measures were necessitated by the increasing sewage disposal loads and also by the fact that water pressures in some areas were near zero, making the flow insufficient for fire fighting.

On the other hand, at Phoenix, Ariz., the superintendent stated (6) in 1948 that "we are in the business of selling water . . . and we welcome . . . new loads which enable us to sell a larger quantity of water, thereby increasing our profits." Phoenix has an infiltration gallery supplying 30 mgd. from the Verde River. In 1947, however, during peak hours, pressures at weak points in the water system had dropped

to as low as 20 psi. The capacity of the source had also been reduced and demands had increased to such an extent that the city was moving to establish a filter plant and pumping station on the Salt River. This would be of 30 mgd. capacity, "to supplement the existing supply for three months each year," in order to meet an estimated maximum-week requirement of 46 mgd. (7). With a population of 120,000 maximum demands are reported as 350 gpcd. for the maximum day

per cent, 60 per cent and no conservation. Under these three conditions, the maximum-day use would reach 555, 635 and 795 mgd., respectively.

Treatment plants now planned will have a rated capacity of 480 mgd. instead of the present 400-mgd. rated capacity. Pumping and distribution changes are likewise in process which will result in a comparable increase in system capacity. With these expanded facilities, estimated to cost about \$60,000,000, the capacity of the system will

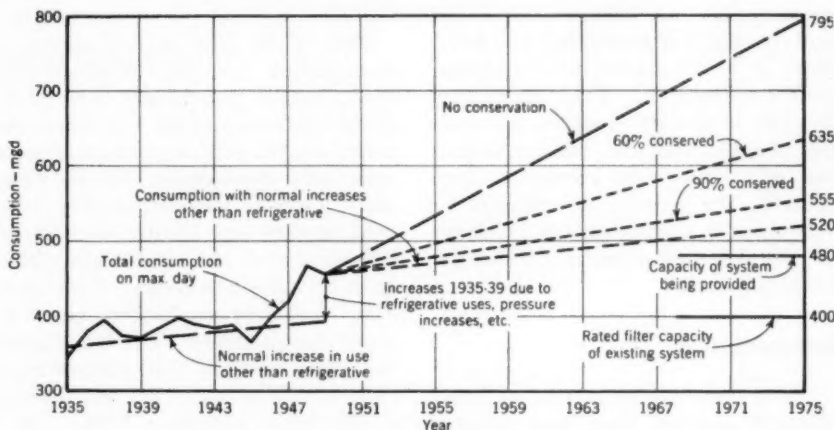


Fig. 3. Relation of Degree of Conservation to Future Consumption

and 475 gpcd. for the maximum hour, the average use being 183 gpcd.

The rated filter capacity of the present system in Philadelphia is 400 mgd. Already, in summer months, it has been necessary at times to operate filter plants at approximately a 20 per cent overload. Figure 3 shows the maximum-day use for the past fifteen years and indicates that, with a normal rate of increase, it will reach 520 mgd. in 1975. Also plotted are consumption growth curves at the present rate of refrigerative installations, assuming 90

be sufficient, assuming a 16 per cent overload, to meet the rise in demand up to 1975, if 90 per cent conservation is attained. (Nonrefrigerative uses are here assumed to be covered by the plotting of normal growth.) If the conservation should be only 60 per cent in 1975, an additional 80 mgd. of capacity will be needed, and, should the conservation be reduced to zero, an additional 160 mgd. of capacity would be required. Provision of such capacity would triple the historical book value or total sum invested by the city.

Growth of Refrigeration

It is of interest to note the growth of the refrigerative machinery industry. The value added by manufacture rose from \$147,000,000 in 1939 to

lar; also, there are other branches of the refrigerative industry which are rapidly increasing, and tremendous increases in total tonnages of refrigeration will continue in future years. To

TABLE 4
Communities With Utility Problems

	No.	Approx. Population
Water Supply		
Communities which have legal restrictions on the use of water for refrigerative purposes	7	11,500,000
Other communities which restrict use for refrigerative purposes by departmental control	14	7,000,000
Other communities which have reported critical supply necessitating action	5	2,200,000
Other communities which have reported critical demands on their systems	5	2,800,000
<i>Total</i>	31	23,500,000
<i>Per cent of U.S. public water supply consumers</i>		25
Sewage Works *		
Communities which have legal restrictions on use of sewers for refrigerative cooling waters	7	1,250,000
Other communities which restrict such use by departmental control	5	4,500,000
Other communities which have reported critical sewage volume problems	5	2,250,000
<i>Total</i>	17	8,000,000
<i>Per cent of U.S. public water supply consumers</i>		9
Combined total communities	48	
Combined total population		31,500,000
Combined per cent of U.S. public water supply consumers		34

* Includes no communities listed as having water supply problems.

\$597,500,000 in 1947. In the same years the number of production and related workers was 39,433 and 108,316, respectively.

The growth of the comfort air-conditioning industry has been spectacu-

illustrate, mention may be made of the tremendous spread of the use of frozen foods in this country; the quick freezing processes for fish, dairy, fruit and vegetable products; expanded refrigeration use in the fishing industry; fruit

juices frozen at high speed to ice flakes, for long-term storage in insulated chambers; maintenance of low temperatures to eliminate static on film storage equipment, thus preventing fires; the installation of refrigerated showcases in very numerous lines; multimillion-dollar research and quality control centers and laboratories; 40-story skyscrapers completely air conditioned with thousands of individually controlled air-conditioning units, using either chilled or hot water, as the season may demand; central station air conditioning, such as was reported last year for a 170-acre tract, containing a completely integrated community of 10,000 persons; use in hospital operating rooms to avoid electrostatic discharges; the use of steam-jet refrigeration to cool windings of turbogenerators, thereby increasing output by 10 per cent; the conditioning of outside show windows to avoid losses because of the heat of the summer sun or frost in winter; and the development of the heat pump.

Textile mills and many other high-demand users are finding the conditioning of air of great importance. Such industries may well employ refrigeration for this purpose without increasing their total water consumption, since the water can be used for regular industrial processes after removing the heat from compressors.

Even in the water works industry, air is being conditioned for the maintenance of dry pump rooms at a Chicago filter plant where plans are laid also to dehydrate the air in the filter galleries. Such dehydration will reduce maintenance costs, and the cooling water used at filter plants need not be wasted, since it can be returned to the plant influent lines.

Effect of Increased Demand

As a result of the marked growth in demand, there are at least 21 water systems which have found it necessary to take action to limit the rate of increase and ten others which are on the border of such action. From various sources, the author has assembled the data summarized in Table 4, which indicates that public water supplies serving 20 per cent of the total population of the United States regulate the use of water for refrigerative purposes, and an additional 5 per cent of the population are served by supplies which have experienced major critical demands. In addition, communities including at least 9 per cent of the population have limited the discharge to their sewers or have experienced critical sewerage conditions paralleling the water situations noted above. Totaling these figures it can be seen that one-third of the population served, and, therefore, of the potential customers for air-conditioning or similar high-water-demand equipment, resides in communities now under a shadow of restraint.

As a result of the various shortages which have occurred, the "Conservation Foundation" has undertaken a survey of water availability. Its scope of study will indicate what can be done in the light of present knowledge to meet these shortages. One of the most important ways to conserve water is by the use of water-saving devices on refrigeration and air-conditioning equipment.

An editorial (8) in a recent issue of *Engineering News-Record* describes the situation as follows: "The overall water supply picture—reduced to simplest terms—is that: More and more

water will be needed by our expanding industrial civilization. And water works men—who are alert to water works needs—must lead boldly in marshalling public support for additional sources and new practice-proven techniques for purifying readily available supplies." And, in the words of another writer, "Increasing consumption, plus new supply problems, make it mandatory that city officials put into full effect all methods for more efficient water use."

All water works engineers and city officials should take note of the full facts of the shortage in New York City, on which the following editorial comment was made by L. H. Enslow (9): "The serious depletion of New York's reservoirs can only in part be charged to a lack of rainfall. According to the U.S. Geological Survey the runoff from the areas feeding New York's reservoirs during the year has been only 'moderately below normal.' Therefore, the principal cause of depletion has been an increase in water use and water waste."

It is interesting to note that the problem of waste has been with the industry since the beginning, as evidenced by this statement, made in 1811: "The watering committee, from a desire to prevent the very great waste of the Schuylkill water which prevails throughout the city [Philadelphia], have published the following statement to show how necessary it is for every person to avoid (and prevent as far as it is in their power) all waste of the water with which the city is so abundantly supplied at a very great expense, which is considerably increased by continual abuses in the use thereof."

The attitude of engineers in the refrigerative industry seems presently to

be most cooperative. An excellent editorial appeared in February 1950 in *Refrigerating Engineering*, the official publication of the American Society of Refrigerating Engineers (10). After outlining the new regulations in New York City, which require conservation on all new units using more than 6 gpm., as well as on an estimated 14,000 existing installations, the editorial continued:

Solution of the water cooling problem for New York air-conditioning systems will set a pattern for other cities. It is unfortunate, perhaps, that New York, the largest city in the world, is one of the first to require recirculatory systems. It would be less of a hardship if water conservation schemes could have first been tried extensively in smaller cities where the problem of cooling tower or evaporative condenser installations was not as complicated as in the congested metropolis. On the other hand, if the refrigerative industry can provide an economical solution in New York, the same solution should prove satisfactory in other localities. It is a problem that would have to be met eventually, if not now, and perhaps it is just as well to establish the industry in a manner that will remove it from the category of a water waster rather than wait until there are many thousands of installations which would have to be redesigned and re-equipped at a later date when water shortages became even more critical than they are today.

Again demonstrating cooperation, in the same issue of *Refrigerating Engineering* appeared the following statement (11): "To cooperate with the new city regulations, the Refrigerating and Air Conditioning Guild, New York Association of Contractors, announces that its members are ready to make *free* inspection of refrigeration

equipment to check defective water valves, and will make necessary valve adjustments to limit water wastage."

At Indianapolis, Ind., the manufacturers of refrigeration equipment ask the plumbers to check with the water company before an installation is made. At present the company supplies only 15 per cent of the water used for air conditioning, private wells supplying the balance. Yet it has been noticed that there has been a definite trend upward in ground water temperature, particularly in the downtown area, where much of this water is returned to the ground.

As bearing on the problem of water recovery in many industries, it may be mentioned that one major objection to the use of open type recirculation water coolers has always been the extreme corrosiveness developed in such waters because of the absorption of gases from the outdoor atmosphere. For instance, C. M. Sterne has shown (12) that, in a period of six days in New York City, the iron and aluminum oxides, as well as the sulfates, have increased from normal tap water concentrations to over 475 ppm.

Articles appearing from time to time in the literature have indicated various degrees of success in combating corrosion. Recent publications appearing in *Refrigerating Engineering and Power*, by such well qualified individuals as Joseph I. Montel, William J. Ryan and Ralph M. Westcott, have reported good progress in corrosion control and definitely indicate that such tendencies may be kept within reasonable limits.

Great savings in water use can be made by many industries. Recently a New York City brewer installed equipment which reduced his consumption to less than half, the cost of which he

will save from his water bill in a period of eighteen months. Such savings should always be encouraged, since the community economy is advanced by them, and when the development of that economy is endangered or inhibited by the lack of such savings, they should not only be encouraged but should be enforced.

Well known nationwide surveys have disclosed that the total water works needs for the country were in excess of \$2.2 billion, which, at present costs, would be swelled to more than \$3 billion. Against such a total, present rates of investment in public water systems seem inadequate. They seem even more so in view of the startling estimate that the total expenditures for industrial water treatment and equipment, in 1950, will exceed a billion dollars.

Economics of Problem

In discussing financing, Alfred O. Norris (13) has stated: "It is quite conceivable that many extensions, although bringing in additional revenue, are, in fact, a financial burden on the system as a whole." This is a possibility which the water works official should consider with regard to all items, as it is manifestly unfair that all consumers should carry burdens created by a few. D. D. Heffelfinger (14) once wrote: "Water departments want new business but they should be certain that it is good business." O. P. Deuel has written (15): "A sound approach to determining a reasonable rate for water service is to base the price on the cost of furnishing the service." The Pennsylvania Public Utilities Commission has ruled that "a public utility cannot be required to make an outlay of capital to extend service where it is

evident that additional revenue will fall short of providing a reasonable return on its additional investment." The items quoted summarize the basic reasons for the preparation of this paper.

Municipal utility incomes, in general, have been so low as to prevent proper maintenance, not to speak of setting up funds for expansion, enlargement or even the retirement of equipment. Utilities cannot continue such a practice. With the average net income of water works increasing only one-seventh as rapidly as construction costs, and with all other costs advancing, it is evident that drastic changes must be made. As has been so well stated by L. R. Howson in a recent excellent article (16) on the costs of water service, "Six per cent return on yesterday's costs will not finance tomorrow's requirements."

A great many municipalities are setting up finance plans which require the systems to be self-supporting. Deficiencies cannot then be taken from taxation or other general revenue of the city. It will be necessary that the rate structures distribute the costs more proportionately to the demand and that they be high enough not only to provide for replacements, but also to cover the amortization of costs of any expansion needed.

Water Cost

This paper will not attempt to deal with extreme situations, and, although some specific examples will be used, the economy of the individual water system will generally be ignored in favor of average conditions and costs. For the purpose of illustration, a cost consistent with conservative business practice, derived from national average figures, will be employed.

There are now nearly 16,000 public water supplies in the United States, serving approximately 100,000,000 people, with a total investment of approximately six billion dollars (3). An average per capita consumption of 125 gpd. would indicate a total investment of \$1,320 for each million gallons actually produced each year.

With municipal-bond yields averaging around 2.5 per cent, a depreciation and amortization average of 6 per cent may be assumed; the costs for these items would then be \$79 per million gallons produced. Operation and maintenance costs vary widely, but, using the mean of \$66 per million gallons derived by Schroeffer (3) for the United States, the average actual cost of water delivered into distribution systems would be \$145 per million gallons. Although, because of leakage and other losses, the rates to the customer would necessarily be much higher than \$145, that figure will be used in this section.

Applying the preceding calculations to *unconserved* refrigerative loadings, it will be found that, for air conditioning, on the basis of 1,000 hours of full-capacity operation per year, the return to the utility should be for approximately 0.1 mil.gal. at \$145, or \$14.50 per year. For refrigeration in the industrial classification, an estimate of 3,000 hours at full loading indicates a total use of approximately 0.3 mil.gal. and a water cost of \$43.50 per ton of refrigeration. The foregoing figures are based on billing entirely by total water use. None of the financial burden of the utility would be carried by these accounts during the large percentage of the time in which the equipment would be idle.

Delving into the phase of investment costs and the fair share of overhead which would be carried by the service, one might consider the means used for such determinations with regard to fire service. A comparison between fire and refrigerative service is somewhat appropriate since the demand rates for air-conditioning use, in various cities, are now running up to several times the fire-demand-rate capacities requested by fire underwriters. The three fire charge bases most used have been: the ratio of maximum fire demand to the total combined system demands; the "comparative" or "separate" plant method; and the "excess" plant method. The second of these will not be considered here but the first method is paralleled in the calculations appearing in the paragraph immediately following, and the third in later calculations.

The national average value of water works is \$480,000 for each million gallons produced daily. Taking the maximum capacity of all systems (sustainable for several days) at the doubtfully high figure of 50 per cent over the average production, and calculating the required yearly return per ton of refrigerative capacity on the basis of 6 per cent for depreciation and amortization, the investment would be \$320,000 for each 1 mgd. of capacity, requiring \$19,200 in annual charges. On the basis of maximum refrigerative demands equaling 1.75 gpm. per rated ton, this would be distributed on 400 tons and would equal \$48 per ton. To this figure should be added the proportionate share of operation and maintenance, or water production cost, which would be the cost of 0.1 mil.gal. at \$66, making the required yearly cost approximately \$55 per ton for air con-

ditioning; or, adding the cost of 0.3 mil.gal. at \$66, the yearly cost for refrigeration becomes \$68 per ton. With these charges, the equipment would be carrying its share of the finance costs throughout the entire year, the major part being for standby capacity throughout the 7,760 or the 5,760 idle hours during the year.

From the foregoing, it may be seen that the cost for the average water works in the United States, calculated on the basis of total water use only, would be \$14.50 per year per ton of nonconserved air conditioning. When the demand and standby capacity are considered and the fair share of cost is allotted, the cost to the utility becomes \$55 per year per ton.

Expansion Costs

Examining the economics of the situation where water supply is becoming scarce, it has been found by the author that, in terms of present prices, the development, or estimated cost of development, of more than 30 new sources of raw-water supply has represented an investment of from \$600,000 to \$1,000,000 to provide 1 mgd. of capacity. Recent preliminary estimates of various sections of the proposed Tri-State Water Supply Project in the Upper Delaware Basin indicate costs of \$500,000 to \$1,200,000 for 1 mgd. Distribution systems generally cost in excess of \$400,000 for 1-mgd. capacity.

It is estimated by the author that, in most locations, 400 tons of refrigerative cooling will increase the demand, and, therefore, the required capacity, by 1 mgd. An outside average cost of providing conservation equipment on installations of more than 5 tons is less than \$150 per ton of refrigerative ca-

capacity, or a total of less than \$60,000 for a 1-mgd. reduction in demand rate.

It is questionable whether the people of a community should be required to invest \$1,000,000 to supply water to certain customers, the need for which might be avoided by the investment of \$60,000, plus, say, \$2,000 annually for additional operation expenses. Proper amortization and depreciation accounting would show a cost of \$50,000 annually to the community, to supply the water which could be conserved by the equipment owners with a total investment of no more than 6 per cent of the cost involved in comparable capacity expansion of the water supply.

As previously stated, the average investment in water works is roughly \$320,000 per million gallons per day of capacity. This means that water works must have an invested value of \$800 for each ton of nonconserved refrigeration for which it furnishes water. Incidentally, this amount is greater than the investment of the owner of the unit. No rates yet in force will yield gross revenue of more than $3\frac{1}{2}$ per cent a year on this figure.

Considering the economics of a specific instance, the Philadelphia refrigerative units would have a peak demand of 270 mgd., on the basis of 70 per cent loading, without conservation. The estimated quantity of use for all the installed tonnage, if unconserved, would be only 12 bil.gal. per year. With separate metering and billing of each installation, the gross revenue would be about \$800,000 per year. After deducting the costs of treatment and delivery of the water used, the remaining income would be sufficient to amortize about \$8,000,000. Treatment plant facilities, at 1949 prices,

range from \$50,000 per million gallon per day of capacity in the larger plants to more than \$100,000 in the smaller plants. Consequently, the \$8,000,000 would construct treatment facilities for no more than one-half of the needed capacity. Nothing would remain toward the provision of pumping facilities, water distribution system or operation.

Information recently published indicated that one of the nation's largest cities is selling 8 per cent of its total production for air-conditioning or refrigeration cooling purposes, receiving \$2,240,000 per year for this water. Refrigerative equipment which would require such an amount of water within a year would have a maximum demand rate in excess of 400 mgd. on hot summer days, even after allowing for a large diversity factor. It is of interest to note that this demand is *four times* the reported fire flow demand of the largest fire known to the author and more than ten times the fire flow requested by fire underwriters for that city. Subtracting from the estimated sum received from the sale of 28,624 mil.gal. of water the average cost of pumping and treating it, there remains about \$1,240,000. At 6 per cent for interest and depreciation, this would amortize an amount which would provide treatment capacity (with low-lift pumping) for a normally rated plant of only 250 mgd., against an increased demand rate exceeding 400 mgd. Will this city build the enlarged treatment plants and also spend millions of dollars on enlarging mains and pumping capacities and more millions on sewage treatment and disposal facilities? Certainly, this is "big business," but can it be called good business for the community?

Proper Income

There has been no uniformity of accounting in water works. Rates of municipally owned systems, with the exception of six states, are not subject to state utility commission control, nor is the use of funds received under such control. Wisconsin and Montana are exceptional states in having utility commissions with power to regulate municipally owned water utility rates and to define proper and improper uses of the funds, including such items as requiring proper reserves for replacements and preventing improper diversion of funds to other municipal uses while the utility is not truly in possession of a surplus. The need for such control may be illustrated by the record of one city which closed the year with a \$39,000 actual surplus but showed on its books a \$40,000 loss, caused by a transfer of \$79,000 to other accounts.

Water rates in the majority of municipal systems have been determined by the following procedure: total annual interest and retirement charges were calculated on outstanding bonds; annual costs of operating the system were estimated and added; and rates to customers, other than the municipality, were arrived at by cut-and-try methods, calculated to yield that amount arrived at as the minimum requirement for the utility to squeeze by—generally limping along on what has been characterized as “half-ration” maintenance.

In contrast, the private utility, in addition to the above items, sets aside a sum calculated to provide for the retirement of all physical properties, whether because of depreciation or obsolescence, and to leave a surplus for extensions and improvements; taxes

are added (generally, largely offset by fire protection and other charges for water for municipal uses) and also claims for return, at some set percentage, on the value of the system. The latter is sometimes taken as the book value or entire cost of the system derived by totaling the recorded costs of construction year after year and subtracting depreciation. Generally, however, the private company obtains an inventory and appraisal of all properties, based on reproduction costs, and subtracts accumulated depreciation to arrive at the depreciated reproduction cost. The various utility commissions and courts have differed on which of these bases should be used for rate-making purposes. The fact that invested value is used is of first importance.

The difference in results, applying these methods of accounting, may be shown by the gross revenue in 1947 of five New Jersey cities compared with five New Jersey companies (17). The gross revenue of the former averaged \$138 per million gallons, that of the latter \$262. After deduction of taxes and general amortization, the respective figures are \$112 and \$163, the latter being 35 per cent greater than the former. Although the operating expenses of the private companies ran \$25 more than those of the municipal systems (no doubt including much more ample maintenance), still the private utilities retained, as net income, \$26 per million gallons, or 63 per cent, more than the municipal systems.

In the average American city (17), assuming [1] an interest rate of 2.5 per cent on an existing debt of approximately \$400 per million gallons or [2] a total of amortization, depreciation and retirement at 6.0 per cent

on a book value of approximately \$1,-320 per million gallons, and using actual average operation and maintenance costs (\$66 per million gallons produced), the average gross revenue per million gallons delivered, in the former instance, should be \$76 and, in the latter, \$145, or 90 per cent greater. The private utility practice of appraisal of reproduction cost, depreciated, as a base for rate making, applied to these cities today, would increase the rate base by 30-50 per cent, or, say, by a mean of 40 per cent.

This increase is due partly to the rate of rise in costs. Another factor, however, is that contributions or assessments, which have frequently paid for extensions, have not been included in the book or historical value of the property. For example, in one city, such assessments were the source of 23 per cent of the total cost of the system, indicating that the book value was only 77 per cent of what it would otherwise be.

Applying this 40 per cent increase in rate base, the average gross revenue to which the utilities are entitled would be raised from \$145 to \$177 per million gallons.

The preceding discussion may be interpreted to indicate that:

1. In a system where the supply of water and the pumping, treatment and distribution facilities are all more than ample, the utility can, without loss, furnish water at slightly above the cost of pumping and treating (since all other costs are fixed). This basis of charging only the cost of producing the added increment is often used to encourage industries, and the rates may run as low as \$45 per million gallons. Such rates can, however, be continued only so long as all the facilities of the

utility are ample in all of its divisions, and a water supply surplus exists, making expansion unnecessary.

2. Common practice in municipal rate setting, covering debt service, operation and maintenance only, might require a gross revenue of only about \$76 per million gallons.

3. On a businesslike basis, providing proper amortization, depreciation and retirement, the gross revenue should be \$145 per million gallons.

TABLE 5
*Income per Million Gallons **

	Income—\$/mil.gal.	
	Water Supply Presently Sufficient	New Sources and Expansion Required
Encouraging use	45	
Common municipal practice	76	143-168
Conservative business practice	145	204-264
Private utility practice	177	

* Customer rates would have to be very considerably higher than the totals above, plus taxes and the like, to offset leakage and other losses.

The figures given herein do not include any taxes, free water service or fund diversions to which the utility may be subject. (Such items may average close to 20 per cent of gross income, throughout the United States.)

These figures are not suggested either as rates of income or as proper commodity rates for any water system. Other than those for new sources, the figures have been derived from average debt, investments and costs and are given for illustrative purposes.

4. Private utilities, as well as municipal systems whose rates are set to provide surplus reserves for improvements, extensions and unforeseen needs, would require an average revenue of not less than \$177 per million gallons.

5. For those systems requiring development of new sources of supply and expansion of existing distribution capacity, or the establishing of new

water works systems, the gross revenue needed may average \$204-\$264 per million gallons, or perhaps even more, depending on the percentage of capacity which can be utilized.

Table 5 summarizes the gross income indicated by these various circumstances.

Application to Refrigerative Uses

With metered water as the sole base of charge, and forgetting standby or

total rated tonnage, or a 1.0-mgd. demand rate for each 400 tons of refrigerative cooling.) A considerable increase in return per ton would be required on a demand basis, as indicated in Table 6. Such are the average costs to the communities; someone must pay them in one form or another. If each class of use does not pay its own way, other classes of uses, or the taxpayers, must pay.

The author wishes to emphasize that

TABLE 6.
*Annual Charge per Ton (Nonconserved)**

	Air Conditioning 100,000 gal. per Year \$/ton	Refrigeration ¹ 300,000 gal. per Year \$/ton
<i>Water Use Basis</i>		
<i>Water supply ample or sufficient</i>		
Encouraging use	4.50	13.50
Common municipal practice	7.00	21.00
Conservative business practice	14.50	43.50
Private utility practice	17.70	53.10
<i>New sources and expansion required</i>		
Conservative business practice	20.40-26.40	61.20-79.20
<i>Demand and Standby Cost Basis</i>		
<i>Water supply ample or sufficient</i>		
Conservative business practice	55.00	98.00
<i>New sources and expansion required</i>		
Conservative business practice	144.00-204.00	157.00-217.00

* The figures given herein do not include any taxes, free water service or fund diversions to which the utility may be subject.

These figures are not suggested either as rates of income or as proper commodity rates for any water system. Other than those for new sources, the figures have been derived from average debt, investments and costs and are given for illustrative purposes.

demand charges, an annual use of 100,000 gal. per ton for air conditioning and 300,000 per ton for refrigeration would indicate yearly charges on unconserved tonnage as shown in Table 6. (The maximum demand rates are taken herein to be equal to a loading of 70 per cent of 2.5 gpm. per ton, based on

water shortages and overloading of sewers are not due to air conditioning alone. Growth and progress play a definite part, and there are many other uses with poor load factors, as well as wasteful uses, where conservation would postpone high investments which must be reflected in water charges.

Summary

Increases in maximum rates of water consumption in recent years have been abnormally high, in comparison with previous years, and indicate a trend of rapid growth in consumption. Public water systems serving more than one-third of the population in the United States now have adopted conservation or some types of restrictive measures, or have experienced critical conditions with regard to water supply or distribution or to sewer capacities and sewage disposal.

The economy of a public water utility will be reflected in the economy of the entire community. Therefore, it is vital to study the economics of supplying water, particularly to individual high-demand industries and to special poor-load-factor services. An understanding of the economics involved will provide a basis for conclusions on [1] the desirability of the utility's furnishing the supply requested or [2] the desirability of modifying certain processes to conserve on water use. Careful consideration should be given to the effect of requiring conservation on the costs of the industry involved.

Where the trend of use indicates the approaching necessity for new supply facilities, or major expansions or enlargements, conservation should be enforced to postpone such necessity. This is emphasized by the fact that rising costs for such construction require major increases in the unit cost of furnishing water.

References

1. MONCHER, S. C. Survey of Water Supply Systems. *Refrig. Eng.*, **56**:2 (1948).
2. LANGBEIN, W. B. Municipal Water Use in the United States. *Jour. A.W.W.A.*, **41**:997 (Nov. 1949).
3. SCHROEPPER, G. J. ET AL. A Statistical Analysis of Water Works Data for 1945. *Jour. A.W.W.A.*, **40**:1067 (Oct. 1948).
4. HOEHLNER, T. E. Stretching New York's Supply. *W.W.Eng.*, **100**:14:803 (1947).
5. Public Works Engineers News Letter (*Am. Pub. Wks. Assn.*), **16**:8:1 (Feb. 1950).
6. Regulation of Water Use in Air Conditioning. Committee Report. *Jour. A.W.W.A.*, **41**:715 (Aug. 1949).
7. American City, **62**:12:113 (1947).
8. *Editorial*, *Eng. News-Rec.*, **144**:12:120 (March 23, 1950).
9. *Editorial*, *Wtr. & Sew. Wks.*, **97**:1:46 (1950).
10. The Shortage of Water Hits Home. *Refrig. Eng.*, **58**:2:133 (1950).
11. New York City Restricts Water Use Sharply. *Refrig. Eng.*, **58**:2:172 (1950).
12. STERNE, C. M. The Control of Corrosion in Air-Conditioning Equipment by Chemical Methods. *Proc. A.S.T.M.*, **35**:2:5 (1935).
13. NORRIS, A. O. Financing Distribution System Extensions. *Wtr. & Sew. Wks.*, **96**:2:65 (1949).
14. HEFFELFINGER, D. D. Financing Main Extensions. *Jour. A.W.W.A.*, **39**:257 (March 1947).
15. DEUEL, O. P. Rates for General Water Service. *Jour. A.W.W.A.*, **42**:327 (April 1950).
16. HOWSON, L. R. Water Works Industry—Healthy or Anemic? *Jour. A.W.W.A.*, **42**:421 (May 1950).
17. CAPEN, C. H. Water Works Revenue and Expenditure. *Jour. A.W.W.A.*, **40**:907 (Sept. 1948).

Quaternary Ammonium Compounds for Main Disinfection

By M. K. Tenny

A paper presented on Oct. 26, 1950, at the Iowa Section Meeting, Des Moines, Iowa, by M. K. Tenny, Asst. Mgr., Water Works, Des Moines, Iowa.

THERE seems to be considerable doubt whether progress in new-main sterilization has kept pace with the betterment of the bacteriological standards for drinking water. At a recent school for water works operators at Iowa City, Iowa, the discussion brought out four methods in general use for this purpose in the state, and a count of those using each method was made, with the following results: [1] flushing with water only—four users; [2] dry hypochlorite powder in each length of pipe—nine users; [3] direct feeding of chlorine gas—two users; and [4] cleaning pipe with solution of quaternary ammonium salts—two users.

The addition of a large tablespoonful of hypochlorite in each joint of pipe still seems to be the most common method of sterilization for new pipe installations in smaller communities. This is probably due to the fact that engineers have been including such a procedure in their specifications for a generation. Under the very best of conditions, some fairly good results have probably been obtained thereby, but, in general practice, this method falls far short of guaranteeing a safe water according to present standards.

More recently chlorine gas dissolved in water has been and is still used in many cities. When a person charged with maintaining satisfactory water

quality in a distribution system has a new main turned over to him already completed and a test of the water does not prove satisfactory, this is perhaps the most convenient method open to him. The procedure usually followed is to introduce chlorine gas from a 100- or 150-lb. cylinder into the new main through a corporation tap placed in it near the point where it connects to the existing pipe, so that a supply of water can flow through the new main carrying the chlorine in solution with it to the far end, where it is allowed to flow to waste out of a hydrant. Chlorinators are manufactured for this type of service and should be used, unless some other provision is made to prevent water from getting back into the chlorine cylinder.

There are many accounts in the literature of sterilization by several hundred parts per million of chlorine, with subsequent considerable periods of standing in the main, which yielded entirely unsatisfactory bacteriological results after blowing off the main to remove the chlorine. Although chlorine is still probably the best all-around disinfecting agent for water from the standpoint of convenience, price and knowledge of toxicity, there are some applications which could be better taken care of by other materials.

In 1945 Calvert (1) published his results with the use of "Klerol,"* the trade name for orthomercurphenol. He used this material in two ways—for sterilization of the jointing hemp and also for cleaning out the pipe before installation. Des Moines used Klerol for some time with good results, both as a solution for soaking the packing for Portland cement joints and also for swabbing each length of pipe before installation. After 1947, however, when quaternary ammonium salts came into more general use, Klerol became difficult to obtain and Des Moines switched to the former (at first, "Q.A.S."† and later, "Polymine D"‡).

Work done by the Wyandotte Co. not related to water supply had shown that the particular quaternary ammonium compound being used was very effective as a germicide when employed with a modified soda approximating in composition a $\text{Na}_2\text{CO}_3\text{-NaHCO}_3$ ratio of 1:1.39. At first the Wyandotte Co. prepared such a mixture and for a limited time put it on the market as Polymine D. Because of the merchandising problems involved, however, they now recommend the purchase of their liquid germicide, called "Spartec," and their soda, under the name of "Yellow Hoop," these products to be mixed in a water solution.

When first used for main sterilization at Wyandotte, Mich., a large quantity of the fairly dilute solution of such a mixture was made in steel drums and pumped with a small portable electric unit into the main to be sterilized, in somewhat the same manner as chlorine

solution is added to a main. This solution was then kept in the main for a week before flushing out and sampling.

Des Moines Procedure

This procedure was reported to give good results, but, because of its satisfactory experience with Klerol, Des Moines decided to depend on thorough swabbing of the pipe at the time of installation, using a more concentrated solution—always with the thought in mind that, if good samples were not obtained, the department could fall back on chlorination. The mixture now being used contains 1 gal. of Spartec, 15 lb. of Yellow Hoop and 20 gal. of water.

The procedure worked out has been to fasten a cotton mop head to a length of $\frac{1}{2}$ -in. pipe. Then the mop is left to soak in a pail containing the mixture. Just before lowering the length of pipe into the ditch, the mop is pushed clear through the pipe, which is then given a half turn before pulling the mop back out. In this way, the entire inside surface of the pipe can be cleaned and also wet with the solution. A good many miles of new mains have been so treated in Des Moines without as yet encountering any bad samples on testing the water after completion.

One local engineer, who has been drawing plans for mains in a number of benefited water districts to connect with the distribution system of the Des Moines Water Works, has been including the following section as a part of the specifications for contractors:

The contractor will be responsible for the sterilization of all mains laid under this contract, and final acceptance will not be made until bacteriological tests made by the Des Moines Water Works are satisfactory. The following procedure may be followed by the contractor:

* A product of Reilly Tar and Chemical Corp., Indianapolis, Ind., not at present in production.

† Made by Mathieson Chemical Corp., New York.

‡ A product of Wyandotte Chemical Co.

Swab thoroughly the inside of each length of pipe just before laying, with a solution made of 1 gal. Spartec and 15 lb. of Yellow Hoop in 20 gal. of water and using lead and Fibrex packing as jointing materials. Spartec and Yellow Hoop are sold by Wyandotte Chemical Co. and Fibrex packing is sold by the Hydraulic Development Corp. of West Medford, Mass.

Samples of water will be taken by the Des Moines Water Works from blowoff connections or other outlets provided by the contractor for this purpose, after construction is completed and bacteriological analyses made thereof. The results of such analyses must meet the requirements of the Public Health Service Drinking Water Standards of 1946.

When the mains are satisfactorily sterilized, and all other requirements have been met, final acceptance of the work will be made.

Packing Material

Probably any discussion of main sterilization should include something about the packing material used. In the past this has commonly been hemp or jute, which normally contains large numbers of bacteria, while the materials themselves are suitable food for many types of bacteria. These packing materials can be sterilized, at least to partial satisfaction. Calvert used copper sulfate and also Klerol for this purpose. Des Moines used Klerol with Italian hemp for cement joints for some time, placing the material in the joint while it was still damp.

A special A.W.W.A. committee recently made an investigation of the suitability of packing materials and, as a result, A.W.W.A. tentative specifications (2) now recommend: [1] molded or tubular rubber rings, [2] asbestos

rope or [3] treated paper rope. Hemp, jute and braided cotton are not recommended by the committee on main disinfection.

For the past year and a half, Des Moines has been using Fibrex, a packing made of chemically treated paper, which has worked out to be more satisfactory and cheaper than the hemp previously used. The material can be used with either cement or lead joints. The use of Portland cement joints without any packing seems to be increasing in popularity, but this procedure has not been followed in Des Moines.

The use only of thoroughly pre-sterilized packings and the exercise of sufficient care in cleaning the inside of water mains have helped to solve the difficult problem of water main sterilization. Only exceptionally should it be necessary to chlorinate a new water main in order to obtain good samples.

Conclusion

In addition to the fact that a good job of sterilizing can be done with quaternary ammonium compounds, such materials are very readily obtainable in smaller communities and can be used by inexperienced personnel. It appears that a more general use of these compounds would be another step toward furnishing safer water to the consumer.

References

1. CALVERT, C. K. Disinfection of New Mains. *Jour. A.W.W.A.*, 37:46 (Jan. 1945).
2. Tentative Standard Specifications for Installation of Cast-Iron Water Mains—7D.1-T-1949. American Water Works Assn., New York (1949); *Jour. A.W.W.A.*, 41:1079 (Dec. 1949).

Methods of Disinfecting Tanks and Reservoirs

By Harry W. Tracy

A paper presented on April 21, 1950, at the California Section Regional Meeting, Santa Cruz, Calif., by Harry W. Tracy, Asst. Engr., Water Purif., San Francisco Water Dept., Millbrae, Calif.

A CASUAL search of the literature reveals few references to the disinfection of new tanks and reservoirs. Even the recently adopted California Section "Standards of Minimum Requirements for Safe Practice in the Production and Delivery of Water for Domestic Use" (1) have failed to make specific mention of this requirement, although they do state that "All pipe or conduits before being placed in service shall be completely disinfected in accordance with A.W.W.A. Procedure for Disinfecting Water Mains" (2). The California Standards do require, however, that "The quality of water supplied for human consumption shall conform to Sections 3 and 4 of the U.S. Public Health Service Drinking Water Standards, 1946." To insure compliance with this requirement or merely to follow good water works practice would necessitate the proper disinfection of any new tank or reservoir through which water passes without chlorination at the outlet.

There is room for argument on what would be a safe disinfecting concentration for each individual tank or reservoir. From an exact scientific standpoint, the concentration should, perhaps, depend upon the contamination present. No doubt coliform-free samples have been obtained from new tanks with no disinfection at all, but the most generally accepted disinfecting concentration is a 50-ppm. chlorine residual.

The A.W.W.A. "Tentative Recommended Practice for Inspecting, Repairing and Repainting Elevated Steel Water Storage Tanks, Standpipes and Reservoirs" (3) includes a note recommending that, just prior to being placed in service, the tank be disinfected by filling with water to which enough chlorine has been added to give a 50-ppm. chlorine concentration.

Disinfection could be performed in a number of ways, but, for the purpose of this paper, they will be classed under three methods: [1] disinfection with chlorine compounds added directly to the reservoir during filling; [2] disinfection with straight chlorine and adding it to the filling water; and [3] spraying the walls, floor and roof with a chlorine solution.

Method 1

The first method—adding a chlorine compound directly to the tank while it is filling, or after it is full—is perhaps the easiest and simplest for small tanks that are accessible. Of the chlorine compounds obtainable, the calcium hypochlorite powders having 70 per cent available chlorine (HTH, Perchloron and others) would be the logical selection under most circumstances. The powder should be evenly scattered over the water surface, preferably as the tank is filling, although it may be done after the tank is filled. A 10,000-gal. tank would require 7.2 lb. of the

powder to give a dosage of 60 ppm. which, after the chlorine demand has been satisfied, should produce a chlorine residual of approximately 50 ppm. With reasonably even distribution of material, the dispersion of the chlorine will be good. No special equipment is required, although the operator should wear goggles to prevent the possibility of the powder getting into his eyes, and a respirator to prevent irritation of the membranes of the nose and throat. Should the diameter of the tank be too great for a satisfactory distribution of the powder by scattering, the compound can be dissolved in water and the solution sprayed over the area beyond scatter reach. Almost any hand pump that will throw the required stream will be satisfactory, if properly washed out after use. As an example, the stirrup pumps distributed under the civilian defense program and later made available at very low cost have been found to work quite well for diameters up to 25-30 ft. If any of the liquid chlorine compounds are to be used, they may be sprayed over the water surface with the same type of equipment.

As a variation of this method, any of the chlorine compounds could be added to the water coming into the tank if the necessary equipment were available, although such a method would probably be desirable only if it were particularly difficult or dangerous to get the material to and spread it from the usual access at the top of the tank.

Although disinfection is practically instantaneous with a 50-ppm. residual, a factor of safety must be provided. The previously mentioned A.W.W.A. tank specifications (3) recommended that the water be kept in the tank at least six hours and, if possible, 24 hours, before dumping.

Method 2

The second method, involving the addition of straight chlorine (either as a gas or in solution) to the incoming water while the tank is being filled, requires the use of some type of portable equipment. Solution feeders are no doubt most commonly used. The portable equipment needed includes the pump and the necessary hose for pump suction and chlorine solution discharge. Also required are the cylinders of chlorine, and connections to obtain a water supply for the chlorinator and to discharge the chlorine solution into the incoming line. The chlorine dosage may be such as to provide a 50-ppm. residual, with the addition to continue during the entire filling of the tank, or a heavier dosage may be used, permitting treatment to stop as soon as sufficient chlorine has been added to give a 50-ppm. chlorine residual in the water when the tank is full.

With this method, the time required for tank disinfection is primarily dependent upon the capacity of the equipment and the amount of chlorine that can be withdrawn from the cylinder or cylinders without freezing. If high rates are to be used, some method of adding heat to the cylinder is necessary. One simple method is to run a stream of water continuously over the cylinder, and, with such practice, a chlorine withdrawal rate of 450 lb. per 24 hours has been maintained with one 150-lb. cylinder until it was approximately three-fourths empty.

If circumstances made it desirable, chlorine could be introduced as a gas into the incoming water with the aid of dry-feed equipment and an appropriate diffuser, provided the back pressure were low. Actually, the chlorine could be fed direct from the cylinder through the diffuser into the incoming water

without the aid of equipment and with chlorine residual tests run on the tank water as a control measure. This method is crude from the standpoint of control, however, and somewhat hazardous as well, for, if water were to get back into the chlorine cylinder, a leak might result or else subsequent use of this container without thorough cleaning and drying would probably damage the equipment.

As a further improvement of this method, the normal overflow pipe may be plugged and additional water added to disinfect all parts of the tank below ventilator openings. This is particularly desirable if roof members were subject to bird or other contamination during construction.

The author's experience with the second method has shown it to be very efficient. About 400 ship potable water tanks were disinfected in this way during the last war, none of which was rejected by the authorities.

Method 3

The third method—a continuous washing of the walls, floor and even roof with a spray containing about 500 ppm. of chlorine—has, it is believed, been used only during the last few years. No reference to such a method has been found in the literature, and its first use by the San Francisco Water Dept. was dictated by circumstances. A 250,000-gal. tank erected several years ago had to be placed in almost immediate service. Time would not conveniently permit the complete filling of the tank and its emptying after a 24-hour retention period. Furthermore, facilities were not available for the quick release of this amount of water in the area. Therefore, the spray method was decided upon, and the tank was disinfected in this manner in June 1943.

With no precedents to use as a guide, a two-hour spraying period and a 200-ppm. chlorine concentration for the spray were adopted. When the tank was sprayed, however, increased concentrations were tried without any difficulties being experienced by the operator. On subsequent jobs, concentrations of 350–700 ppm. were used with no detrimental effects. As the full chlorine concentration in the spray is doubtless not maintained between passes, a figure of 500 ppm. is offered as a recommended concentration to be used in the spray for wetting tank and reservoir walls over a two-hour period. This would seem to give a most adequate factor of safety for disinfection without harming the common protective coatings.

The equipment required for this method is a solution-feed chlorinator with high-pressure fittings, a pump to provide an adequate water supply, suction hose for the pump, sufficient chlorine discharge hose with appropriate nozzle for convenient spraying in the tank, and a gas mask and raincoat for the operator in the tank. For safety precautions, an additional gas mask, some rope and a lineman's safety belt should be provided.

The San Francisco Water Dept. uses portable chlorination equipment, built some fifteen years ago, consisting of a Wallace and Tiernan high-pressure chlorinator (Type A303), a 25-gpm. triplex pump driven by a gas engine and all necessary accessories mounted on a trailer with space provided for 150-lb. chlorine cylinders. Usually 100 ft. of 1-in. hose is used to carry the chlorine solution discharge, and the nozzle is made up of a $\frac{1}{4}$ -in. pipe nipple with a $\frac{1}{4} \times \frac{3}{4}$ -in. reducer attached to a $\frac{3}{4}$ -in. pipe nipple which is inserted into the 1-in. hose. A more efficient stream could be obtained with a regular $\frac{3}{4}$ -in.

fire hose nozzle, but its life would be somewhat limited by the corrosive action of the chlorine solution, and its purchase hardly seems warranted. Injectors of size 193 or 242 are used on the chlorinator, and the water pressure from the pump is usually maintained in a range from 200 to 300 psi. A water pressure of 300 psi. on a No. 193 injector will, according to the Wallace and Tiernan injector-operating water curves, throw a 17-gpm. stream, requiring a chlorinator setting of 102 lb. per

relief man, who sits on the top of the tank at the opening and watches operations. The spray man, who is dressed in boots, raincoat and gas mask, finds the work somewhat warm and uncomfortable, and, therefore, the men ordinarily change places at about 20-minute intervals. Each operator checks his mask for leaks before entering the tank and, although the work is not particularly hazardous, the spray operator, as a precautionary measure, wears an ordinary lineman's safety belt, to which

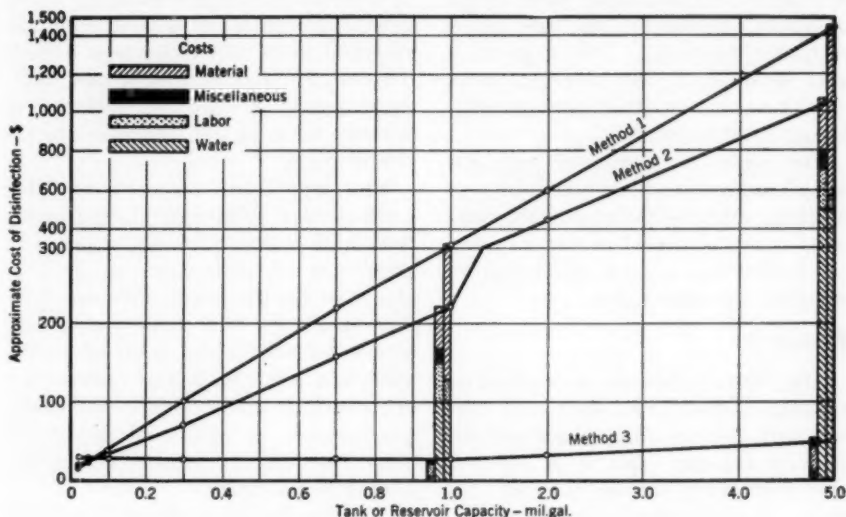


Fig. 1. Comparison of Costs of Disinfection Methods

24 hours to give a chlorine concentration in the stream of about 500 ppm. Similarly, a water pressure of 200 psi. on a No. 242 injector will throw a 22-gpm. stream, requiring a chlorinator setting of 132 lb. per 24 hours to give a 500-ppm. chlorine concentration in the discharge. If pressures are inadequate to reach the top of the tanks, the usual solution is a smaller nozzle.

Normally, three men are on the job, one with the chlorination equipment, one man in the tank spraying, and a

relief man, who sits on the top of the tank at the opening and watches operations.

If access to the tank is by a manhole near the bottom of the tank, operations are somewhat simplified and two men can easily perform the job.

The top and walls of the tank are sprayed for two hours with the tank drain valves closed, permitting the highly chlorinated water to collect on the floor. Any grossly contaminated particles, if present on walls or ceiling, will probably be washed to the floor,

where they may receive even more than the two-hour contact with the chlorinated water. Following the spraying operation, the water may be immediately drained from the tank, or, if time allows, draining operations may be delayed until the next day.

the water, permitting two sprayers to operate, might be desirable to speed up the work.

Comparison of Methods

For comparison purposes, Fig. 1 and Table 1 have been prepared, showing

TABLE 1
Comparison of Disinfection Costs

Item	Tank or Reservoir Capacity—gal.						
	20,000	50,000	100,000	300,000	700,000	1,000,000	5,000,000
Method 1—HTH (70% Cl ₂)							
Material used—lb.	14.3	35.7	71.3	214	499	713	3,565
Material cost—\$/lb.	0.48	0.28	0.28	0.28	0.26	0.26	0.24
Material cost—\$	6.86	10.00	19.96	59.92	129.74	185.38	855.60
Labor—man-hours	2	4	4	6	12	16	48
Labor cost (\$1.75/hr.)—\$	3.50	7.00	7.00	10.50	21.00	28.00	84.00
Water cost (10¢/1,000 gal.)—\$	2.00	5.00	10.00	30.00	70.00	100.00	500.00
Total cost—\$	12.36	22.00	36.96	100.42	220.74	313.38	1,439.60
Method 2—Cl ₂ —Filling Tank							
Material used—lb.	10	25	50	150	350	500	2,500
Material cost (10.5¢/lb.)—\$	1.05	2.63	5.25	15.75	36.75	52.50	262.50
Labor—man-hours	4	6	8	12	24	30	130
Labor cost (\$1.75/hr.)—\$	7.00	10.50	14.00	21.00	42.00	52.50	227.50
Waste water cost (10¢/1,000 gal.)—\$	2.00	5.00	10.00	30.00	70.00	100.00	500.00
Equipment charge—\$	5.00	5.00	5.00	5.00	10.00	15.00	75.00
Total cost—\$	15.05	23.13	34.25	71.75	158.75	220.00	1,065.00
Method 3—Cl ₂ —Spraying Tank							
Material used—lb.	12.5	12.5	12.5	12.5	12.5	12.5	20.00
Material cost (10.5¢/lb.)—\$	1.31	1.31	1.31	1.31	1.31	1.31	2.10
Labor—man-hours	12	12	12	12	12	12	18
Labor cost (\$1.75/hr.)—\$	21.00	21.00	21.00	21.00	21.00	21.00	31.50
Waste water cost (10¢/1,000 gal.)—\$	0.30	0.30	0.50	0.50	0.70	1.00	10.00
Equipment charge—\$	5.00	5.00	5.00	5.00	5.00	5.00	10.00
Total cost—\$	27.61	27.61	27.81	27.81	28.01	34.31	53.60

This method is applicable for any size of reservoir, provided sufficient chlorine solution discharge hose is available. For large reservoirs, however, a larger stream or even splitting

the estimated cost of disinfecting tanks or reservoirs of various sizes by each of the three methods. Certain assumptions were necessarily made: labor cost, \$1.75 per hour; waste water cost, 10¢

per 1,000 gal.; and portable equipment charge, \$5.00 per day (eight hours or less). As the equipment was assumed to be on the job, any haulage charges would be extra, and no allowance was made for the crew's travel time. The maximum output of the equipment was assumed to be 500 lb. of chlorine per 24 hours, and an operator was assumed to be present while the equipment was in use. Chemical costs were figured from current prices: chlorine—150-lb. cylinders; hypochlorite—5-lb. cans in case lots for tanks under 50,000-gal. capacity, and 100-lb. drums for larger tanks. Dosages for Methods 1 and 2 were assumed to be 60 ppm. to give a 50-ppm. residual.

The advantages of Method 1 are primarily for small tanks, of 50,000 gal. or less. No special equipment is required, one man can do the job, good distribution of the hypochlorite can be attained and only a relatively small amount is required. The disadvantages of the method are that the material is too expensive to warrant its use for large tanks or reservoirs, some hazard is involved in treating elevated tanks, and difficulties may be encountered in distributing the material over very large areas.

The second method seems to have no general advantage over the other two from an economic standpoint, with the assumptions here used. It would have certain operational advantages, however, when disinfecting elevated tanks and would have a cost advantage over Method 1 on all but small tanks. It would be advantageous to employ this method rather than Method 3 if the chlorinated water could be reused to disinfect lines leading to or from the reservoir. The prime disadvantage is that portable equipment is necessary and the rate at which chlorine can be

added to the water is limited to the capacity of the equipment, which would seldom exceed 500 lb. a day.

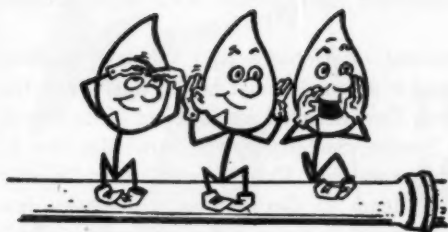
The third method is economically advantageous for all tanks or reservoirs with capacities in excess of about 100,000 gal. Little water need be wasted, and the job can be completed and the tank put in service within a comparatively short period of time. The disadvantages are that more men are usually required during operations, additional equipment is needed, some hazard is involved in working in an atmosphere containing chlorine gas and the method is not well adapted for elevated tanks.

Selection of Method

Assuming that equipment and facilities are available, selection, in general, will favor Method 1 for tanks of 50,000-gal. capacity and under, Method 2 for elevated tanks and Method 3 for tanks and reservoirs of more than 100,000-gal. capacity. The cost curves particularly emphasize the value of the spray method in the larger-capacity reservoirs. With tanks having capacities ranging from 50,000 to 100,000 gal., the costs of all three methods are fairly comparable, and the choice will be governed by local conditions and individual preferences.

References

1. California Water Supply Standards. *Jour. A.W.W.A.*, 41:1 (Jan. 1949).
2. A Procedure for Disinfecting Water Mains—7D.2-1948. American Water Works Assn., New York (1948); *Jour. A.W.W.A.*, 40:131 (Feb. 1948).
3. Tentative Recommended Practice for Inspecting, Repairing and Repainting Elevated Steel Water Storage Tanks, Standpipes and Reservoirs—7H.2-T-1949. American Water Works Assn., New York (1949).



Percolation and Runoff

The proverbial good from that ill wind that almost blew the Northeast down right after Thanksgiving seems to have been deposited in good part to the credit of public water utilities in the New York metropolitan area. With almost 300 deaths and at least half a billion dollars in property damage throughout the area, the blessing did almost too good a job of disguising itself, but there's little question that it took a load off the minds of the many water works men who had been fretting about reservoirs which were below the danger mark for a second year in a row. The big blow itself and two smaller ones that followed hard on its gale brought with them enough rain to send some water over the top at New York City's Schoharie Reservoir and to boost supplies generally to figures that more than doubled those of last year. Next thing you know, the area will be borrowing California's boots and worrying about a flood.

Speaking of the rain, though, we are glad to report that, although the city's rainmaker was out during the height of the storm trying to wring the last drop out of those clouds, no one took time out from his own gust bust to blame it all on Dr. Howell.

Rainmakers have, as a matter of fact, managed somehow to get a foot inside the door of respectability—not only in New York when New Yorkers weren't looking, but almost everywhere and for apparently better reasons.

Most recently it has been the king-size King Ranch of Kingsville, Tex., which has given its blessing—in the form of a contract to Precipitation Control Co. of Phoenix, Ariz., for a trial project during this winter. Thus, with Arizona, California, Nevada and New Mexico already lined up behind the seeders, we have the makings of a solid Southwest. And if that expression has a familiar ring of a different timbre, lend an ear to General Electric's Dr. Bernard Vonnegut, discoverer of silver iodide seeding, who spends a good bit of his time these days sounding the alarm of politics and

(Continued on page 2)

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controls—even diplomacy—as imminent interferences with indiscriminate insemination.

And if worry about government interference isn't the last word in respectability, worry about a suit for damages must be. Thus, when the Bar Association of the City of New York selected as a subject of its annual moot court competition for the Samuel Seabury Silver Bowl the case of *John Fayerweather v. Henry Wetmore and Rain Control, Inc.*, seeding was sold. Although the winning team of Georgetown University law students took the part of John Fayerweather, the panel of six judges, which included such famous names as Associate Justice Jackson of the Supreme Court and Judge Harold R. Medina of the U.S. District Court, held that no legal precedent came out of the arguments of student lawyers from 42 different law schools throughout the country. Moot though the suit was, however, it probably seeded some of the best legal-minds-to-be in the country.

What price respectability?

Monroe doctrine experienced a temporary setback last November, all because a water main scraper stuck in that New York village's only supply line. Not that Monroe's indoctrinees cared—what with no school and no bath water the decadent little imperialists were having a ripsnorting time. It was their parents who suffered—a real water shortage, too, despite the fact that the lake to which their mains connected was full and ready to serve.

All in all, the metal ball scraper that was put in the main at the lake to be forced through by water pressure spent a full five days in the line choking off all or all but a trickle of water, despite even the booster pumping by the fire department. When at the end of that time the water started trickling a little faster, the problem still wasn't solved, for the scraper was still in the line—and cutting it out would, of course, require still another shutdown.

What Mayor Peter L. Smith and his Monroe village board need is an Open Door.

(Continued on page 4)

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(Continued from page 2)

United effort by the entire membership of A.W.W.A. is required for the preparation of the Tenth Edition of *Standard Methods*. An appeal from Ray L. Derby, committee chairman, requests that members correspond with the relevant subcommittee chairmen concerning revisions or improvements they feel should be made in the manual. Addresses of the chairmen, who are listed below, may be found in the 1950 Directory, or the A.W.W.A. office will forward letters addressed to them in its care.

<i>Subcommittee and Topic</i>	<i>Subcommittee Chairman</i>
S-3 Color and turbidity	William L. Harris, Grand Rapids, Mich.
S-4 Taste and odor	Oscar Gullans, Chicago, Ill.
S-5 Volatile suspended and fixed solids, residue by evaporation, residue by electrolytic conductance	K. W. Brown, San Francisco, Calif.
S-7 Alkalinity, acidity, carbon dioxide	Michael Taras, Dearborn, Mich.
S-9 Total hardness, calcium, and magnesium	Joseph J. Connors, Oakland, Calif.
S-10 Sodium and potassium flame photometry	Edward B. Showell, Wilmington, Del.
S-11 Silica, iron, aluminum, manganese	R. A. Bardwell, Danville, Ill.
S-12 Copper, lead, zinc, chromium	John T. Cross, Chicago, Ill.
S-14 Fluoride	Charles A. Black, Gainesville, Fla.
S-16 Phosphates	Charles E. Kaufman, Pittsburgh, Pa.
S-17 Sulfate	Robert S. Ingols, Atlanta, Ga.
S-19 Residual chlorine, chlorine demand	H. H. Gerstein, Chicago, Ill.
S-22 Test interference by free chlorine	Howard M. Nelson, Jacksonville, Fla.
S-23 Chlorides, bromine, iodides	Martin E. Flentje, Philadelphia, Pa.

General comments should be addressed to Ray Derby, Box 3669 Terminal Annex, Los Angeles 54, Calif.

Winters sure is hot these days, so hot in fact that they've had to bring water cooling into the picture—into movie actress Shelly Winters' forthcoming picture, that is, where she and actor John Garfield do some of what her unwaterwise press agent calls "cuddling in the chlorine." That it's really water in which the "action" takes place and, furthermore, that "it's sexier that way," Shelly, herself, has been all too ready to confide, "in quotes." And who among us is to say it isn't good clean fun?

With Winters here can springs be far behind?

(Continued on page 6)

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*Samples and Data on Request

(Continued from page 4)

Copies of "Proceedings of the Fifth Industrial Waste Conference" are now available from Purdue University. Orders for the 430-page bulletin, which is priced at \$1.00 per copy, should be addressed to Dean W. A. Knapp, Executive Bldg., Purdue University, Lafayette, Ind. The Sixth Conference is to be held February 21-23, 1951. Further information may be obtained from Prof. Don E. Bloodgood.

Reprinting of the 1943 and 1944 reports of the Committee on Depreciation of the National Assn. of Railroad and Utilities Commissioners has made these reports available again, bound together as a single volume. Copies may be obtained from NARUC, Box 684, Washington 4, D.C., at a cost of \$4.50.

Reilly Tar & Chemical Corp. has just opened a new plant at Lone Star, Tex., for the production of pipeline enamel and other tar products. The plant will use the entire by-product plant output of the new Lone Star Steel Co. foundry, which began operations simultaneously (see November P&R, p. 18).

(Continued on page 8)

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(Continued from page 6)

The use of a-c. network calculators for distribution system analysis has aroused considerable interest in this age of technical marvels. Last month's publication of a paper by Suryaprakasam, Reid and Geyer (December issue, p. 1154) was the second in the JOURNAL. The September issue of the Texas Engineering Experiment Station *News* (p. 16) mentions similar work done on the \$250,000 calculator of the Texas A&M Research Foundation. And back in April (p. 347; also see this issue, P&R, p. 22) McIlroy described in the JOURNAL a type of electric analyzer utilizing specially designed nonlinear resistors, in which the electric current-water flow analogy can be maintained over a wide range without inaccuracy. The day may yet come when each glass of water is ordered by push-button and its delivery is charted and computed by an electronic brain. Researchers with imagination might even couple individual delivery with custom-treatment: softening (and maybe even heating) for bath or laundry water, the addition of wetting agents for firefighting, and even a slug of fluorides for the little tots to sip.

Plugged, wooden or what-have-you, a nickel, these days, is about as useful as the buffalo which appears on it. That was the text of a recent discourse by Columnist Bill Ladd in the Louisville, Ky., *Courier Journal* and that's been the text of our own tears for years. About all you can get for a Louisville nickel these days, Bill pointed out, is a newspaper, a picture postcard or an underprivileged Christmas card. A New York nickel is about the same, what with six-cent candy, eight-cent bus fare, and dime subways, dime telephone calls—even dime coffee at the Automat. Worse than that, the pinball machines give you only a single ball for a nickel now, whereas you used to be able to get five times the exercise and entertainment for the money. Is it any wonder, then, that, with his week's savings burning a hole in his pocket, Bill had to get in touch with Henry Gerber, President of the Louisville Water Co., to make a sound investment—one ton of water, that is, purified, delivered and uninflated.

(Continued on page 10)

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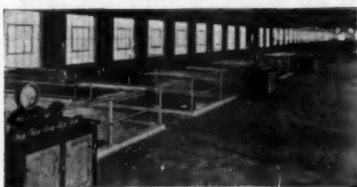
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638 COLUMBIA AVENUE • DARBY, PENNSYLVANIA

(Continued from page 8)

Got a thirst? Corn can quench it. Figures cited by Virgil Overholt, state agricultural engineer in Ohio, indicate that it takes 20 tons of water to make a single bushel of corn. And when you consider how many bushels it takes to make a single gallon of corn, you ought to get the idea.

On the basis of old Overholt's calculations we can point out that, even if we were to drink eight glasses of water a day, it would take us more than 27 years to consume the equivalent of what goes into one bushel of corn. On the basis of our own, we feel certain that, as corn, we could toss off a 27-year supply of drinking water without letting go of the jug. All of which ought to give a lot of people a boost up on the water wagon.

Talk of going on the water wagon, though, reminds us of Sam Kutz of Oklahoma City, who actually made a business of it. Having retired after a 24-year career as a successful bootlegger in dry Oklahoma, Sam went to work again on January 1—as a city constable. What Sam's exact motives were in wanting, as he said, "to get on the other side of the fence," we aren't sure, but certainly Oklahoma City's voters are to be commended upon their recognition of excellent qualifications for enforcing their dry laws. As a matter of fact Sam was unopposed in either the primaries or in the general election, which is probably more than can be said of his entry into his previous profession.

That still small voices are operated by the same people who may later manipulate uproarious ones is a fact that commissioners of the North Jersey District Water Supply Commission are now trying to turn to their own advantage. Having played host to fourth-graders of a Montclair school at its Wanaque Reservoir, the commissioners were tickled pink to receive thank-you letters from three of them and to learn, for instance:

We appreciate you for letting us come to the dam. We liked the control station, it was nice. We liked the beautiful grass.

We liked the dam with its slanted face. And we liked the beautiful blue water. It makes the mountain beautiful.

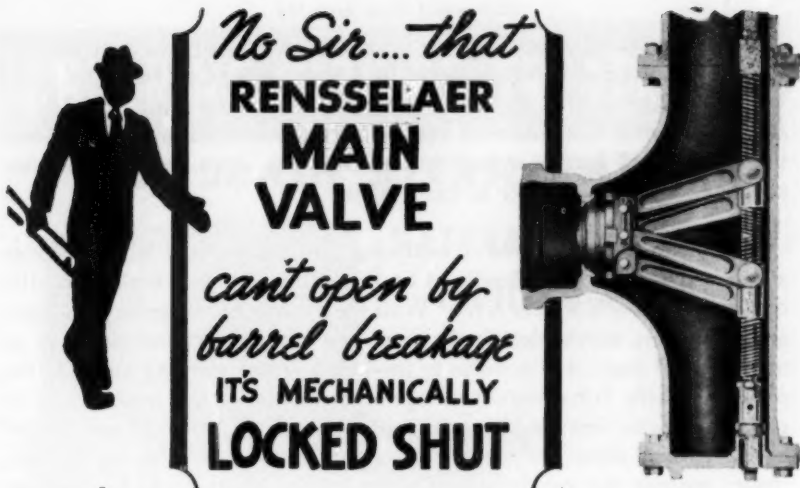
or, from a young lady:

We appreciate your letting us come to Wanaque Dam. It is a beautiful place to live at. I hope you protect it. And I don't want anybody swimming in it, because I don't want to drink dirty water and I don't think anybody else would either.

If such sentiments can be inculcated in nine-year-olds by a single trip to a reservoir, the commissioners feel, it should be part of a water works' future planning to establish a youth education movement. What with the anguished howl now being heard about North Jersey's Ramapo River diversion project, appreciation such as the above gets a warm welcome.

Don't rob the cradle, but be sure to sign it up.

(Continued on page 12)



HERE'S another feature of the famous Rensselaer Hydrant—NO FLOODING if barrel is broken. The main valve is **MECHANICALLY LOCKED** shut by steel forgings bearing solidly against the case. Valve seats stay tight—won't leak or scar. This Hydrant can't open unless the stem is rotated.

What's more, if the standpipe is broken off, the ground line flange makes replacement quick and easy—no pavement breaking, no digging.

Yes, this Rensselaer Hydrant is a first-class investment. All working parts lift out easily, quickly. No water hammer. Drains fast without clogging. Solid bronze gives long life to vital parts. In short, **SOUND DESIGN**, a sound buy, proven by thousands in service making good the Rensselaer reputation. See a Rensselaer Representative for details—just call our nearest office.

THE FAMOUS RENSSELAER HYDRANT



See how....
**THE FLANGE AT
GROUND LINE
ELIMINATES
DIGGING UP**

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LEADERSHIP FOR OVER 65 YEARS

RENSSELAER VALVE COMPANY

Hydrants • Gate Valves • Square Bottom Valves
Check Valves • Tapping Sleeves and Valves • Air Release Valves

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Division of Neptune Meter Company

Atlanta, Bala-Cynwyd, Pa., Chicago, Denver, Haverhill, Mass., Kansas City,
Los Angeles, Memphis, Oklahoma City, Pittsburgh, San Francisco, Seattle, Waco

(Continued from page 10)

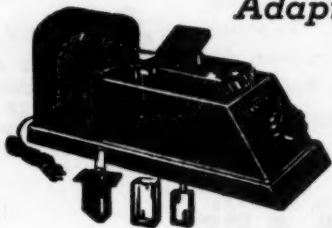
A concrete or pavement saw for making neat openings in street surfaces for excavation is being offered by Clipper Mfg. Co., Dept. JA, 2800 Warwick, Kansas City 8, Mo. The Clipper Concrete Saw, gasoline or electric powered, is available in three portable models, each offering a cutting speed of 12 fpm. in asphalt and up to 5 fpm. (1-in. cut) in limestone concrete. Maximum depth of cut is $6\frac{1}{2}$ in.

A mechanized method of analyzing consumption and billing for rate study purposes has been developed by Recording and Statistical Corp., 100 Sixth Ave., New York 13, N.Y. With the use of a bill frequency analyzer, an instrument which electrically sorts and tabulates consumption in as many as 300 steps, it is possible to produce a report showing instantly the number of bills (or customers) together with their total consumption in gallons or cubic feet for any consumption step. A "consolidated factor" column, which shows the cumulative consumption in any step for all bills, makes possible the speedy determination of the revenue which a rate increase in any given block could be expected to produce. The device was used with considerable success by electrical utilities before being offered to the water supply field.

(Continued on page 14)

KLETT SUMMERSON ELECTRIC PHOTOMETER

*Adaptable for Use in Water
Analysis*



Can be used for any determination in which color or turbidity can be developed in proportion to substance to be determined

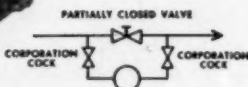
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FOR MAIN STERILIZATION

NATURAL EMERGENCIES

CIVILIAN DEFENSE



For use in by-pass around partially closed gate valve acting as a variable orifice to maintain a light disinfecting residual while main is in use.

%Proportioneers% equipment for Chlorine Dioxide treatment is ideal for the emergency sterilization of a portion of a system while in use, *without taste and odor difficulties*. Faced with the necessity for main sterilization while the mains were in use, a Rhode Island town of 30,000 persons used %Proportioneers% equipment with complete success. One 10" main 8,000 ft. long was put in use after 20 years and sterilized over a two weeks period. A residual of 0.5 ppm as measured with O.T. gave an actual residual of approximately 1.5 ppm Cl and ClO_2 without taste or odor. Installation was easily made in a by-pass as shown in the diagram. Sterilization was entirely successful.

Chlorine Dioxide feeding with %Proportioneers% equipment is simple, automatic, and always in exact proportion to flow through the main. Pressure in the main operates the Chem-O-Feeders, without need of electricity or other outside power. The system is complete with Treet-O-Control Meter and improved Chlorine Dioxide Generator.

Now is the time to prepare for emergencies — be ready! Write today for complete information.

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(Continued from page 12)

Cyrus W. Rice has stepped down as president of Cyrus Wm. Rice & Co., consulting water chemists, in favor of H. E. Einert. He will continue, however, as board chairman.

W. F. Weimer has been appointed advertising manager for Rockwell Mfg. Co. He succeeds William A. Marsteller, who has resigned to establish a market consulting service.

David B. Lee, chief sanitary engineer and director of the bureau of sanitary engineering for the Florida Board of Health, has been elected president of the Florida Public Health Assn.

Walter Moffat Scott, commissioner of the Greater Winnipeg, Man., Water District—and also of the corresponding sanitary district—has resigned after thirty years of service. He had been chairman of the board of water commissioners from 1920 to 1949 and of the sanitary district group from its inception in 1937 until 1949. After retiring as chief commissioner a year ago, he continued to serve on both boards, and is now making his retirement complete.

(Continued on page 16)

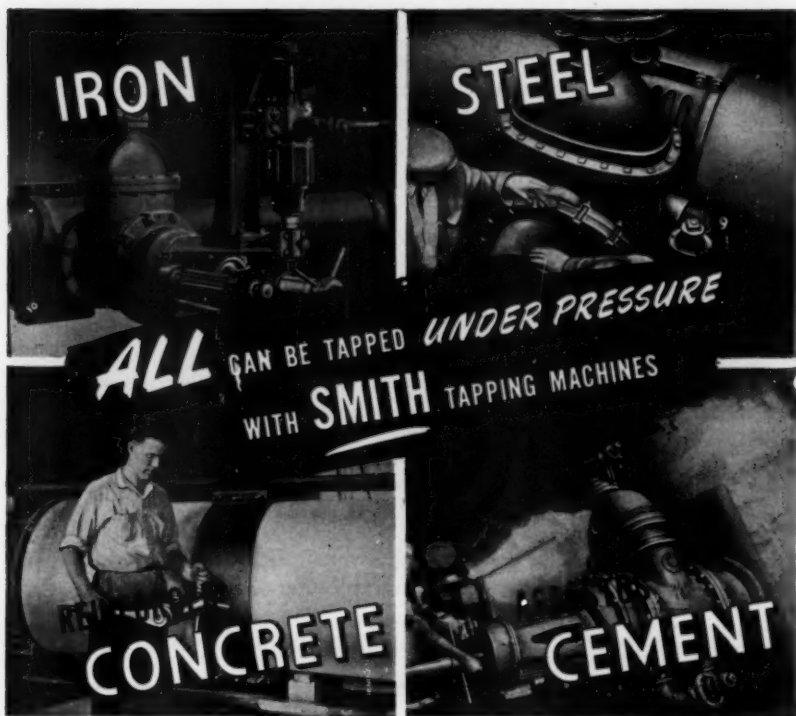
Now Available: WATER QUALITY & TREATMENT

Second Edition—Revised and Enlarged

A.W.W.A.'s manual of *Water Quality and Treatment* brought up to date, with chapters on: source characteristics; aquatic organisms, quality standards, stream pollution and self-purification, impounding reservoir control, aeration, coagulation, mixing and sedimentation basins, disinfection, taste and odor control, filtration, scale and corrosion control, softening, iron and manganese removal, boiler water treatment, fluoridation, and treatment plant control. With four appendices and an index, that makes 451 pages.

Price: For general sales, \$5.00. For A.W.W.A. members sending cash with order, \$4.25

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500 Fifth Avenue New York 18, N.Y.



WITH Smith tapping equipment you can make branch connections up to 42" in diameter under pressure to any type or size of pipe, without interrupting service, draining the line, or riling the water. These machines are used with SMITH tapping sleeves, hat flanges, and tapping valves. The entire operation is quick, simple and satisfactory.

Write for further information.

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 EAST ORANGE, NEW JERSEY

FLOOR STAND
 INDICATOR POSTS
 TAPPING MACHINES
 INSERTING MACHINES
 PIPE CUTTING MACHINES

(Continued from page 14)

The gift horse angle was featured by *Natural Resources Notes* in noting the story of a portland cement company which, enjoined by court action to cease "damaging" nearby farms with dust discharged from the plant, put in dust collectors and sold the limestone dust to the complaining farmers for land improvement. But, then, show us the water consumer who wouldn't rather pay almost any price for his supply rather than get the same amount free through a fireman's hose.

A single-tank deionizer said to offer greater economy and simplicity of operation than multi-tank models is being offered by Elgin Softener Corp., Elgin, Ill. The use of cation and anion exchangers having a marked difference in density permits ready separation by backwash into two zones for individual regeneration. A multiport valve and supplementary controls govern backwashing, regeneration, mixing of exchangers for service and actual operation.

Cochrane Corp. has purchased the Pottstown Metal Products Co., which will be operated as an independent subsidiary. The metal company was Cochrane's chief source of softener and filter shells and other parts.

(Continued on page 20)



M-SCOPE Pipe Finder

LIGHTWEIGHT MODEL

Catalog No. 25K

On Request

JOSEPH G. POLLARD CO., INC.

Pipe Line Equipment

New Hyde Park

New York



Coating-Jobs

just don't come too big for Koppers!

▼ Look at the 120-foot section of 66-inch steel pipe pictured above. It's only a *small fraction* of the new 10,000-foot intake pipe line of the Saginaw-Midland Water Project, Saginaw, Michigan. This entire pipe line, inside and out, has been protected against corrosion with Koppers Bitumastic* 70-B Enamel.

From start to finish, Koppers Contract Department handled this tremendous coating job. Some of the 40-foot joints weighed approximately 14 tons; yet Koppers skilled workmen, using specialized spinning equipment, easily coated the pipe's interior with a glass-smooth spun lining. Saginaw can now be certain that its pipe line will be protected against rust, corrosion and tuberculation . . . can be certain that the flow capacity will *remain* high.

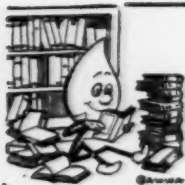
Why not submit your corrosion problems to our Contract Department? Write us today.



PROTECTIVE COATINGS

*T. M. Reg. U. S. Pat. Off.

KOPPERS COMPANY, INC., Dept. 114-T, Pittsburgh 19, Pa.



The Reading Meter

Survival Under Atomic Attack. *National Security Resources Board Doc. 130. U.S. Government Printing Office, Washington 25, D.C. (1950) 10¢*

Intended for popular distribution, the availability of this 32-page booklet—either as a desk copy, in bulk (a 25 per cent discount is offered for quantities over 100) or as a source for quotation or reproduction—should be noted by all public officials and others responsible for any facet of civil defense. In point-by-point question and answer style, it offers simple explanations of the dangers, the probabilities and the course of action to adopt.

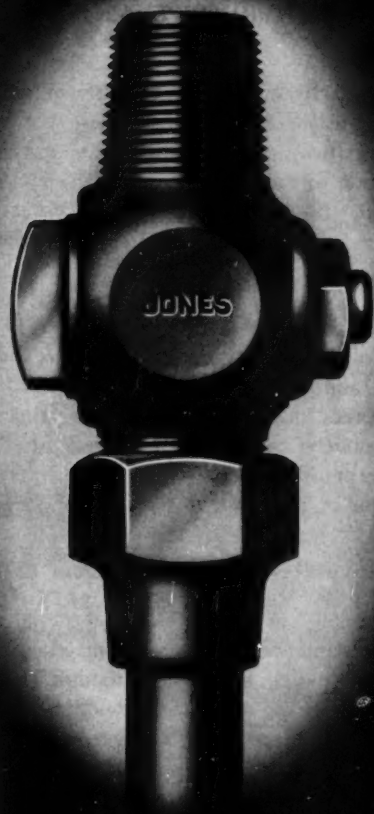
Atomic Warfare. Manual of Basic Training—Vol. II. *Home Office Civil Defence Pamphlet No. 6. His Majesty's Stationery Office, London (1950) 2s*

A more detailed exposition of the material covered by the U.S. booklet reviewed above, this British manual gives more technical information and data on heat flash, radioactivity, blast effect, and even explains the simple elements of atomic physics necessary for an understanding of the bomb's workings.

Engineering Hydraulics. *Proceedings of the Fourth Hydraulics Conference, Iowa Institute of Hydraulic Research, June 12–15, 1949. Hunter Rouse, ed. John Wiley & Sons, New York (1950) \$15*

Intended as a comprehensive reference work on applied hydraulics, this 1,039-page volume represents the combined efforts of thirteen authors whose efforts were directed and correlated by the Iowa Institute of Hydraulic Research. Chapters on flow principles, similitude and the use of models, flow measurement, hydrology, ground water flow, flow in pipes, water hammer, sediment transportation and hydraulic machinery are among those which round out the scope of the book. In preprint form, the chapters received a critical review at the 1949 conference of the institute and were extensively revised as a result.

(Continued on page 20)



JONES

JAMES JONES COMPANY

LEROY AND ST. JOHN STREETS, LOS ANGELES 12, CALIFORNIA

ESTABLISHED 1892

The Reading Meter*(Continued from page 18)*

Public Health Engineering—Vol. II. The food contact. Earle B. Phelps with Walter D. Tiedeman. John Wiley & Sons, New York (1950) \$4

Treating primarily of foods—especially milk and shellfish—food handling and food waste disposal, this volume will interest those whose public health activities are not limited to water supply matters. It forms a companion to the first volume of the series, which appeared in 1948 and dealt with man's air and water contacts.

Municipal Affairs. Ernest W. Steel. International Textbook Co., Scranton, Pa. (2nd ed., 1950) \$5.50

A revision of the 1941 edition, this book covers the general field of organization and administration of municipal departments and functions. Chapters on the relationship of the municipality with utilities, both publicly and privately owned, offer the water works specialist a concept of his place in the municipal scheme of things, from the manager or administrator's point of view.

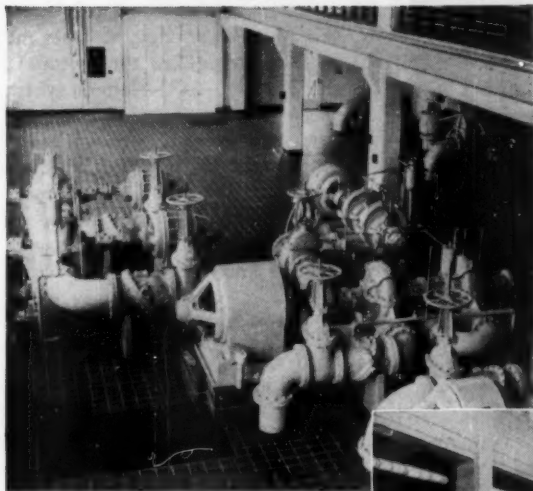
Ion Exchange Resins. Robert Kunin & Robert J. Myers. John Wiley and Sons, New York (1950) \$4.75

This text was intended both as an introduction and a reference work for this burgeoning field, and although designed to cover all applications it gives generous space to deionization and water softening. Although it contains only 212 pages, of which the text proper occupies only 173, a prodigious list of 615 references points the way to those who want more information. The book's chief value appears to reside in its usefulness as a survey of a very new and largely unorganized field.

(Continued from page 16)

The whole staff of the Lakemore, Ohio, water department joined A.W.W.A. in a body last month. The body's name was Oliver Russell Bush, only employee of the town's water and sewer utilities. Among the duties Mr. Bush noted on his application were: "handle all repairs, billing, pumping, chlorinating, bookkeeping, meter reading, installations, collections, deposits, etc." In this one case, the application wasn't returned for an explanation of *etcetera*, with the thought, of course, that a man's spare-time activities are his own business.

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Ramuc Utility, a glossy, chlorinated-rubber enamel, beautifies walls, ceilings, concrete floors. Unaffected by lime in green concrete. Stays colorfast, hard, under strongest cleansers.

Torex Enamel lends sparkling, tile-like beauty to concrete filter basins... adds to the general attractiveness and cleanliness of the plant. Long-lasting, easy-to-clean Torex discourages mud-ball formation, is not softened by water, chlorine, soda ash or alum.



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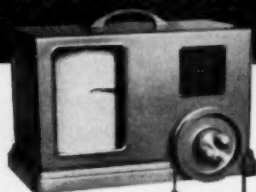
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The Bendix-Friez FW-1 Water Level Recorder is portable and sturdy. It is widely used by government and other hydrological services. Charts and speeds are available for periods from 6 hours to 8 days.



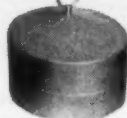
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Universal Recording Rain Gage is vital in determining rain and snowfall for run-off purposes. Bendix-Friez also makes remote recording rain gages and other instruments, useful in water works technology.



Correspondence

Ups . . .

To the Editor:

Some day I shall send you a little note giving you the details of letters which have been coming in from my paper last spring in the JOURNAL [April issue, p. 347]—letters which have been a source of real pleasure and interest. It's interesting to watch the circulation travel around. The latest letter came from a consulting engineer in South Africa. It really keeps me busy. If anyone thinks the JOURNAL isn't read, I know better!

MALCOLM S. McILROY

Prof. of Elec. Eng.

Cornell Univ.

Ithaca, N. Y.; Dec. 11, 1950

. . . and Downs

To the Editor:

. . . Looking at your JOURNAL from a position not directly in the water works field, I have these comments to make:

1. The JOURNAL has too many articles on plant management, accounting practices, description of plants, etc., and not enough articles on technical subjects such as theory of treatment processes, application of statistics to interpretation of data, analytical methods, effects of radioactive materials, etc.

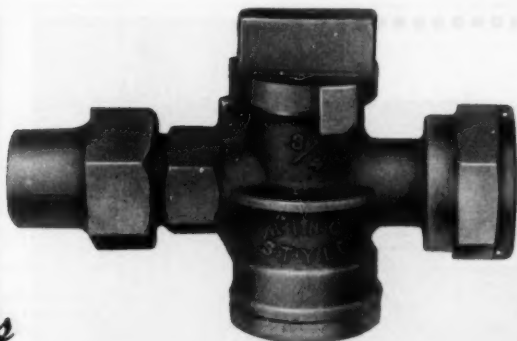
2. The contents page in the JOURNAL is not conveniently located and I do not like advertising matter interspersed in abstracts, news of the field, etc. . . .

KEENO FRASCHINA

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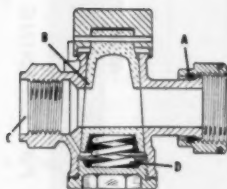
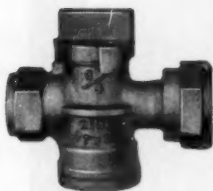
San Francisco 22, Calif.; Nov. 27, 1950



This

METER VALVE

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Permitting "in-line" setting of meters in tight space, the Ford Straight Ringstyle Valve also saves fitting labor and at least one coupling.

This valve enjoys all of the advantages of the famous Ford Angle Ringstyle valve. Note these features: (A) Ringstyle coupling that eliminates a pipe joint as well as a coupling (B) Recessed key that keeps deposits from damaging valve surfaces (C) "Set-in" threads to protect threads of iron pipe and (D) Bronze spring that keeps key in place. No leather gasket required, prolonging valve life.

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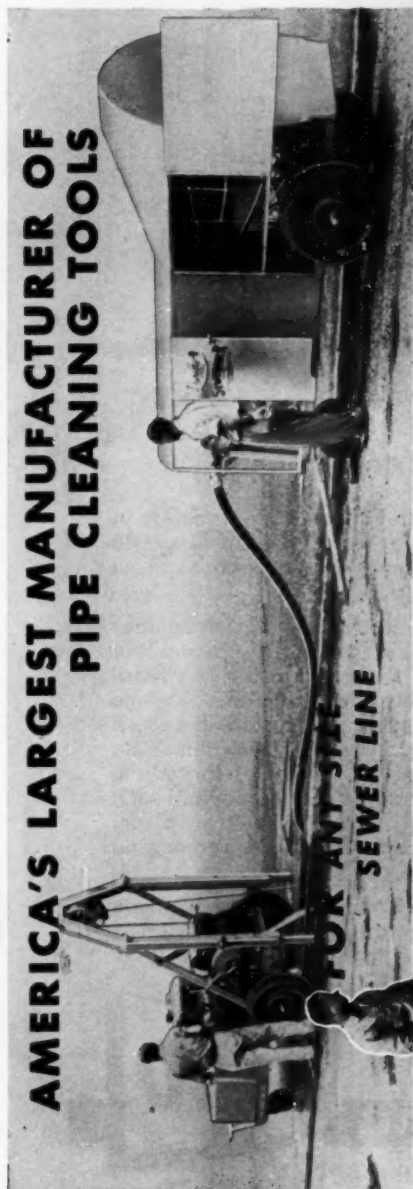
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Membership Changes



NEW MEMBERS

Applications received November 1 to 30, 1950

Anderson, H. Kenneth, Hydr. Engr., Bureau of Water Works, City Hall, Portland 4, Ore. (Oct. '50)

Benson, Carl E., Water Dept., 485 N.E. 129th St., North Miami, Fla. (Oct. '50)

Best, James Joseph, Jr., City Engr., Joiner, Ark. (Oct. '50) *MP*

Bivens, Douglas, Supt., Waldron Munic. Water Works, Waldron, Ark. (Oct. '50)

Blan, Jim R., Sales Repr., Aurora Pump Co. & Waterous Co., 6008 Columbia Ave., Hammond, Ind. (Oct. '50) *MR*

Borenstein, Arnold, Water Treaters of Chicago, 1946 W. Montrose Ave., Chicago 13, Ill. (Oct. '50) *P*

Brisbin, Sterling G., Graduate Student, Massachusetts Inst. of Technology, 318A Graduate House, Cambridge 39, Mass. (Jr. M. Oct. '50)

Brown, W. Otis, *see* Wytheville (Va.)

Buehrer, C. G., *see* San Ysidro (Calif.) Irrigation Dist.

Bush, Oliver Russell, Water & Sewer Dept., Box 1195, Lakemore, Ohio (Oct. '50)

Byrd, Dan, Supt., Water Dept., Eustis, Fla. (Oct. '50)

Cassidy, Donald Edward, Pipe Line Supt., Southern California Water Co., 1206 S. Maple St., Los Angeles, Calif. (Oct. '50) *M*

Chapman, C. F., Supt. of Water, Box 235, Lodi, Ohio (Oct. '50)

Clark, Darrell F., *see* Hartford City (Ind.) Water Works

Coghlan, S. F., *see* Montgomery, J. M. & Co., Inc.

Davis, Charles Herman, Water Works Operator, City Hall, Oberlin, Ohio (Oct. '50)

Dickson, Glenn, Asst. Director Plant Coordination, California Packing Corp., 101 California St., San Francisco, Calif. (Oct. '50) *P*

Dooley, James R., Operating Engr., Water & Sewage, Post Engr., Fort Lee, Va. (Oct. '50)

Due, Chas. W., Exec. Secy., Kenton County Water Com., Dist. No. 1, 31 E. 7th St., Covington, Ky. (Oct. '50)

Fuger, J. E., *see* Pocatello (Idaho) Water Dept.

Gallaher, Hugh M., Director of Public Works, Hayward, Calif. (Oct. '50) *M*

Gamble, George Edwin, Joint Managing Director, c/o John Thompson, 312 Flinders St., Melbourne, Australia (Oct. '50)

Gleason, A. L., Supt. of Water, 214 Chestnut Ave., Geneva, Ohio (Oct. '50)

Gravos, Paul E., Owner & Mgr., Culligan Soft Water Service, 429 W. 3rd St., Red Wing, Minn. (Oct. '50) *P*

Gregory, John S., Civil Engr., 152 E. Glenarm St., Pasadena 2, Calif. (Oct. '50) *M*

Halpin, David J., Student, Massachusetts Inst. of Technology, Graduate House, Cambridge 39, Mass. (Jr. M. Oct. '50)

Hartford City Water Works, Darrell F. Clark, Water Works Supt., Hartford City, Ind. (Corp. M. Oct. '50)

Ireland, H. E., Sales Engr., Worthington Pump & Machinery Corp., Hoffmann Hotel, South Bend, Ind. (Oct. '50)

Jackson, Norman E., Civil & San. Engr., Dalecarlia Filtration Plant, 5900 MacArthur Blvd., Washington, D. C. (Oct. '50) *MPR*

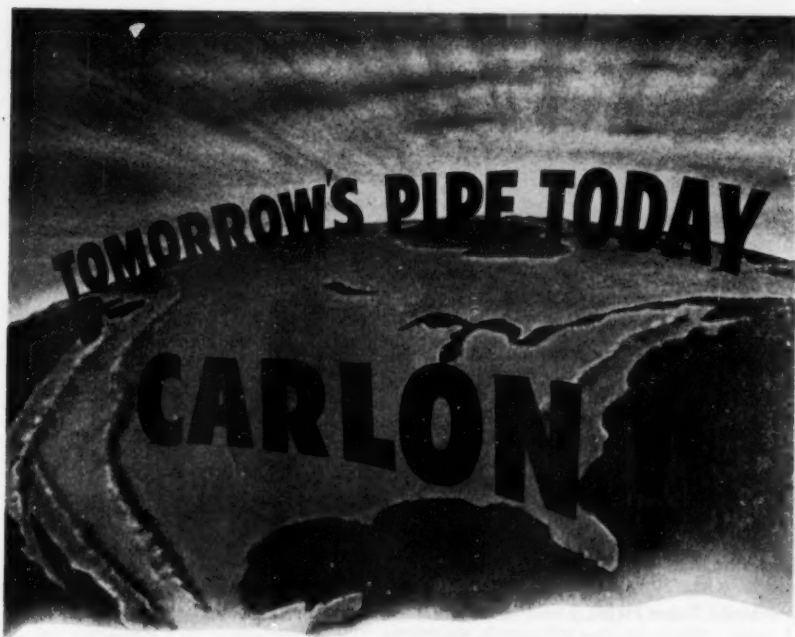
Klein, Lawrence E., Plant Operator, Water Dept., North Miami, Fla. (Oct. '50) *M*

Lackey, C. E., *see* Newton (N. C.)

Laing, Roberts W., City Manager, Alliance, Neb. (Oct. '50)

Lawless, Kenneth D., Sales Engr., Bowser, Inc., 607 Main St., Fenton, Mich. (Oct. '50)

(Continued on page 32)



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(Continued from page 30)

Lynch, John P., Chemist, Water Dept., Springfield, Mass. (Oct. '50)

McLean, Lowell G., Assoc., J. R. Lester Boyle, 328 Spurgeon Bldg., Santa Ana, Calif. (Oct. '50) *M*

Menefee, E. V., see Rising Sun (Ind.) Munic. Utilities

Montgomery, J. M., & Co., Inc., S. F. Coghlan, Pres., 900 S. Robertson Blvd., Los Angeles 35, Calif. (Corp. M. Oct. '50) *R*

Newton, City of, C. E. Lackey, Supt., Newton, N. C. (Corp. M. Oct. '50) *M*

Ostrom, John Avar, Engr. La Mesa Irrigation Dist., 4769 Spring St., La Mesa, Calif. (Jr. M. Oct. '50) *R*

Peirson, Frank L., Salesman, Los Angeles Chemical Co., 1960 S. Santa Fe, Los Angeles 21, Calif. (Oct. '50) *P*

Petrie, Ralph W., Cons. Engr., 557 Paw Paw Ave., Benton Harbor, Mich. (Oct. '50) *M*

Pickett, John T., Civil Engr., Pahokee, Fla. (Oct. '50) *PR*

Pocatello Water Dept., J. E. Fuger, Water Supt., 118 N. 1st Ave., Pocatello, Idaho (Mun. Sv. Sub. Oct. '50)

Renner, Ralph Edward, Mgr., Alaska Public Utilities, Box 716, Cordova, Alaska (Oct. '50)

Rising Sun Munic. Utilities, E. V. Menefee, Mgr., 1st & Poplar Sts., Rising Sun, Ind. (Mun. Sv. Sub. Oct. '50)

Roll, Jakob, Student, San. Eng., Massachusetts Institute of Technology, 396 Marlborough St., Boston 15, Mass. (Oct. '50)

San Ysidro Irrigation Dist., C. G. Buehrer, Pres. of Board of Directors, Box 5, San Ysidro, Calif. (Corp. M. Oct. '50) *MPR*

SeEVERS, William M., Office Mgr., Munic. Water System, Box 58, Hayward, Calif. (Oct. '50)

Short, Lawrence J., Pres., Culligan Soft Water Service, Wayzata, Minn. (Oct. '50)

Smith, Wilbur A., Supt., Waynedale Water Co., Inc., 6901 Elzey St., Fort Wayne 6, Ind. (Oct. '50) *M*

Spaulding, Florence S. (Miss), Secy., Boyce Co., Inc., 504 Pennsylvania Ave., Clearwater, Fla. (Oct. '50)

Taylor, Lansing N., Supt. of Utilities, Tavares, Fla. (Oct. '50) *M*

Wilson, Harry S., Asst. Civil Engr., Dept. of Water Supply, Gas & Electricity of City of New York, 309 Boro Hall, Staten Island 1, N. Y. (Oct. '50)

Wisda, James William, Jr., Civil Eng. Asst., Los Angeles Dept. of Water & Power, 3669 Terminal Annex, Los Angeles 54, Calif. (Oct. '50)

Wortley, Ralph S., Mgr., Uniontown Water Co., 74 E. Main St., Uniontown, Pa. (Oct. '50)

Wytheville, Town of, W. Otis Brown, Supt., Water Plant, Wytheville, Va. (Mun. Sv. Sub. Oct. '50)

Yawn, Beverly H., Salesman, Johns-Manville Sales Corp., 311 Consolidated Bldg., Jacksonville, Fla. (Oct. '50)

REINSTATEMENT

Preston, Alfred Emery, Master Mechanic, Metropolitan Water Dist. of Southern Calif., 306 W. 3rd St., Los Angeles, Calif. (Oct. '43)

LOSSES

Deaths

Barbee, Edwin W., Assoc. Civ. Engr., San Francisco Water Dept., Millbrae, Calif. (Jan. '36) *P*

Hoover, Charles P., Supt., Div. of Water, Columbus 8, Ohio (May '13) *Fuller Award '43. Honorary M. '48. MPR*

Ivy, Joseph W., Western Sales Mgr., National Cast Iron Pipe Div., James B. Clow & Sons, 1104 Land Bank Bldg., Kansas City 6, Mo. (July '42) *MP*

Kells, Thomas J., Repr., Neptune Meter Co., 2118 Roosevelt Ave., Burlingame, Calif. (Apr. '45)

Salter, Fitzgerald, Asst. Mgr., City Water Works Board, City Hall, Montgomery, Ala. (July '38)

Smith, Vernon, Mng. Director, John Thompson-Australia-Pty., Ltd., 312 Flinders St., Melbourne, Australia (Jan. '35)

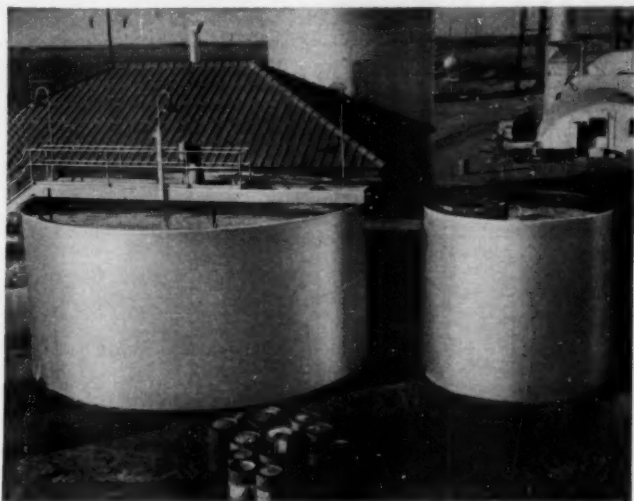
CHANGES IN ADDRESS

Changes received between November 5 and December 5, 1950

Burgess, John A., 3812 N. Dearborn St., Indianapolis, Ind. (Oct. '48)

Chaney, Lee F., Star Route, Tacoma, Wash. (Apr. '44) *P*

(Continued on page 34)



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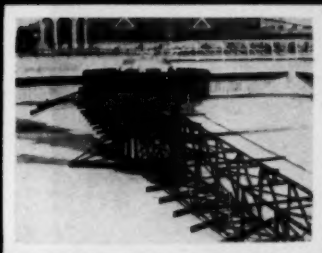
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(Continued from page 32)

Cox, Sherman J., Economist, Bureau of Reclamation, Water Resources Development, Box 651, Huron, S. D. (July '50)

Desmond, Leo E., Eastern Sales Mgr., The Central Foundry Co., Murray & Pacific Sts., Newark 5, N. J. (Apr. '46)

de Sousa Taveira, Antonio Augusto, Civil Engr., Rua de Paula Vicente, 171, Porto, Portugal (Jan. '50) *PR*

DeVoe, Sherman W., Engr., Sales & Service Dept., Colorado Pump & Supply Co., 160 S. Canosa Court, Denver 9, Colo. (July '50)

Pena Duran, Luciano, Carrera 6, No. 8-67 Edificio Calero, Cali, Colombia (Apr. '46)

Fiesler, Frederick A., R.R. 7, Box 199, Decatur, Ill. (Jan. '44) *MP*

Gordon, F. G., 6900 South Shore Dr., Apt. 606, Chicago 49, Ill. (June '21)

Greenberg, Arnold E., 207A Eng. Materials Lab., Univ. of California, Berkeley 4, Calif. (Jr. M. Jan. '49)

Grossman, Irving, 1476 Main St., E., Rochester, N. Y. (Jr. M. Apr. '50) *PR*

Klein, Howard, U. S. Geological Survey, Ground Water Branch, Box 348, Coconut Grove Station, Miami 33, Fla. (Oct. '48)

Muddiman, John B. C., 1310 Cherokee Rd., Louisville, Ky. (July '39) *MPR*

Peterson, Carl J., City Water Plant, Box 809, Great Falls, Mont. (Jan. '45)

Phillips, William Fred, Sales Engr., Byron Jackson Co., 205 Irwin-Keasler Bldg., Dallas 1, Tex. (Apr. '50)

Porter, Fred S., 130 Linden, Apartment 301, Long Beach 2, Calif. (Oct. '32) *M*

Rich Mfg. Co. of California, 3851 Santa Fe Ave., Los Angeles 58, Calif. (Assoc. M. Sept. '27)

Root, Darrell A., Camp, Dresser & McKee, 6 Beacon St., Boston 8, Mass. (Apr. '42) *MP*

Shephard, Robert O., Soil Conservation Service, 408 E. Govan, Grenada, Miss. (Jan. '43) *R*

Teller, Carl Freeman, McCormick & Teller, Cons. Engrs., Box 6276, Houston 6, Tex. (Jan. '48)

Truman, Chester A., Route 1, Box 228, Gresham, Ore. (Dec. '26) *Director '37-'40. Fuller Award '45.*

Wright, John D., Allentown Water Works, 1300 Lawrence St., Allentown, Pa. (Jan. '49)

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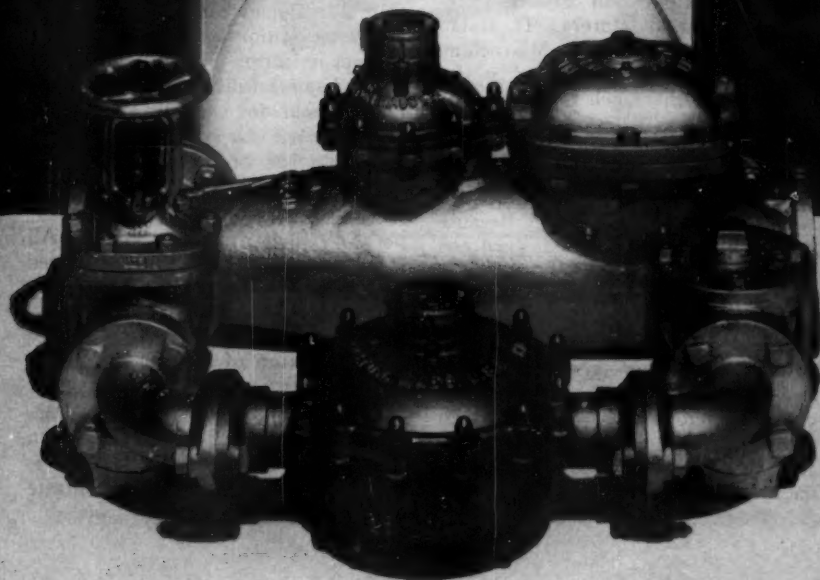
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Key: In the reference to the publication in which the abstracted article appears, 39:473 (May '47) indicates volume 39, page 473, issue dated May 1947.

If the publication is pagged by the issue, 39:5:1 (May '47) indicates volume 39, number 5, page 1, issue dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *B.H.*—*Bulletin of Hygiene (Great Britain)*; *C.A.*—*Chemical Abstracts*; *Corr.*—*Corrosion*; *I.M.*—*Institute of Metals (Great Britain)*; *P.H.E.A.*—*Public Health Engineering Abstracts*; *S.I.W.*—*Sewage and Industrial Wastes*; *W.P.R.*—*Water Pollution Research (Great Britain)*.

CHEMICAL ANALYSIS

Rapid Methods for Determining Fluoride in Waters. WALTER E. THRUN. *Anal. Chem.*, **22**:918 ('50). Rapid detns. of fluoride in water can be made colorimetrically with dil. soln. of Al lake of eriochrome cyanine. Small samples are used and comparisons can be made within 10–15 min. after mixing. Auxiliary distn. method is described for samples contg. excess of interfering substances. Reagents, app. and procedures for both methods described. Interferences discussed and comparison of results given. There is excellent agreement between two methods within precision that can be expected.—*C.A.*

Enrichment and Microdetermination of the Lithium Ion, With Particular Consideration of Its Presence in Mineral Waters. H. BALLCZO. *Mikrochemie ver. Mikrochim. Acta*, **35**:178 ('50). Method is described in detail which is suitable for detg. as little as 0.02% Li in 1 g. of total solids obtained from mineral water. Li adsorbed chromatographically on column of Al_2O_3 pretreated with alkali at pH 12.5–12.6. Because of high pH, ions of second, third and fourth groups, as well as Mg, are pptd. previously to this treatment. Accumulated Li in column is eluted with 2N HCl and sepd. from impurities present by means of dioxane-hydrochloric acid and abs. dioxane. The LiCl is then converted into borate by ignition with H_3BO_3 and aq. soln. of melt is titrated for borate content with methyl red-methyl violet mixed indicators.—*C.A.*

Determination of the Nitrate Ion by the Noll Method. O. A. ALEKIN & E. N. CHERNOVSKAYA. *Voprosy Gidrokhim.*, **32**:74 ('46). To clarify certain points concerning use of brucine method of Noll for detg. nitrate ion in fresh waters, following points were studied: [1] establishment of min. quant. of water for detn.; [2] conditions of treatment of water with brucine; [3] time of reaction of brucine and nitrate solns.; and [4] proportionality of color change with change of nitrate content. Source of nitrate for expts. was soln. of KNO_3 made up in lab. Results were expressed by ratio of columns of liquids in colorimeter cylinders at time when colors were matched. 5 ml. was found to be min. amt. of water with which to start detn. It was learned that best results were obtained by detn. of nitrate on samples contg. 6–50 ppm. of NO_3^- . Conditions of analyses had to be kept uniform. For instance, there had to be uniformity as to type of containers used for reaction, and same pipet was used for introducing sulfuric acid soln. of brucine into samples. Also reaction times had to be same in any series of samples for which comparable results were expected. All conditions studied suitably illustrated by tables of data obtained from the expts.—*C.A.*

Determination of Nitrate in Water. GEORG GAD, MARGARET KNETSCH HILDE SCHLICHTING. *Gesundh.-Ing.*, **69**:137 ('48); *Chem. Zentr. (Russian Zone Ed.)*, **II**:760 ('48). In colorimetric detn. of small amts. of nitrate

(Continued on page 38)

ACCURATE



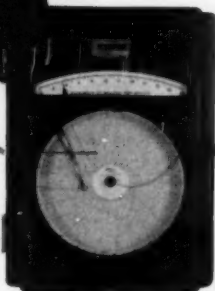
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(Continued from page 36)

with brucine, color developed depends on amt. of brucine soln. added, time and H_2SO_4 concn. Following procedure is recommended, with dry glassware being used: 0.15 ml. of 5% brucine soln. in glacial HOAc and 5 ml. concd. H_2SO_4 are added, in order, to 2.5 ml. of water sample in 10-ml. graduated cylinder. After whole has been mixed and allowed to stand for 30 min., it is transferred to 13-mm. cell of Hellige comparator and compared with sample of distd. water treated in same manner. Best results obtained in range 4-10 ppm. of N_2O_5 . —C.A.

Titrimetric Determination of Dissolved Oxygen in Water Without the Use of Iodine-containing Reagents. GEORG GAD. *Gesundt.-Ing.*, 69:22 ('48); *Chem. Zentr.* (Russian

Zone Ed.), II:342 ('48). In oxidimetric method of Leithe, conversion of $Mn(OH)_2$ ppt. into $MnCO_3$ usually not necessary. Ppt. is satisfactorily dissolved by acid mixt. contg. H_2SO_4 and H_3PO_4 or, better, by 50% H_2SO_4 in presence of pyrophosphate. Ferric salts and nitrite in concns. up to 5 ppm. do not interfere. Addn. of azide is not only unnecessary but, because of subsequent reduction, is undesirable. 100-ml. water sample collected as usual is treated with 0.5 ml. $MnCl_2$ soln. and 0.5 ml. 33% NaOH and shaken vigorously for 1 min. After ppt. has settled completely, supernatant liquid is siphoned off down to about 20 ml. Then 0.5 g. Na pyrophosphate and 5 ml. 50% H_2SO_4 are added. After soln. of ppt., 1 drop of 2% soln. of diphenylamine in concd. H_2SO_4 is added and sample is titrated with 0.01N $FeSO_4$.

(Continued on page 40)



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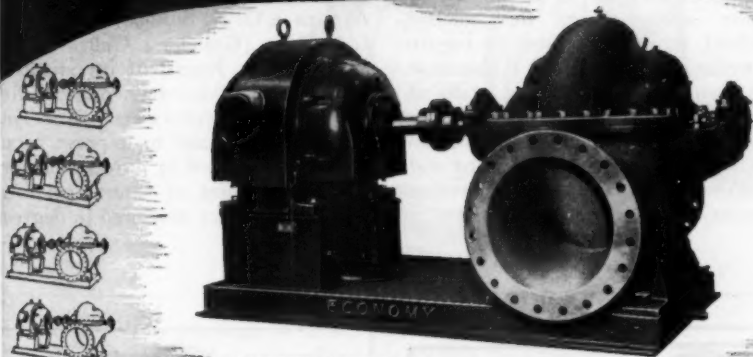
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(Continued from page 38)

soln. End point is change from violet-blue to yellow-green.—C.A.

Estimation of Dissolved Oxygen in Deaerated Water. J. ARNOTT, J. MCPHEAT & F. B. LING. Engineering, 169:553 ('50). To prevent corrosion, deaerated water with residual O content of 0.005 to 0.02 ml. per l. is specified for feedwater in high-pressure steam boilers. Water showing zero result with Winkler method may contain up to 0.02 ml. O per l. To increase sensitivity of this method, 1000-ml. sample is treated by regular procedure up to point of I liberation. I is then extd. with 4 extns. of 30 ml. each of CCl_4 . I in solvent is removed by water contg. slight excess 0.02N $\text{Na}_2\text{S}_2\text{O}_3$ and excess back-titrated with 0.02N I. Magnitude of individual sources of error was investigated as

well as effect of variations in sampling technique. Max. probable error was ± 0.002 ml. O per l. Large-scale app. is described for prepn. of deaerated water with mean O content of 0.0007 ml. per l. Illustrations show simple wooden stand made for convenience in holding sepg. funnels, 4-way sampling connection and type of buret employed.—C.A.

Method for Determination of the Oxidizability of Water. O. A. ALEKIN & O. K. SOKOLOVA. Voprosy Gidrokhim. (Gosudarst. Gidrol. Inst.), 32:81 ('46). Report of investigation to study conditions detg. oxidizability of naturally colored waters by Kubelya-Timan method, and to improve accuracy of this method by introducing corrections. Extent of natural color of water sample was measured in degrees

(Continued on page 44)

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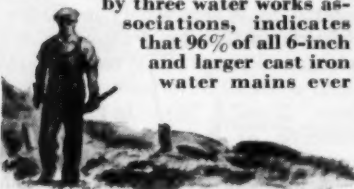
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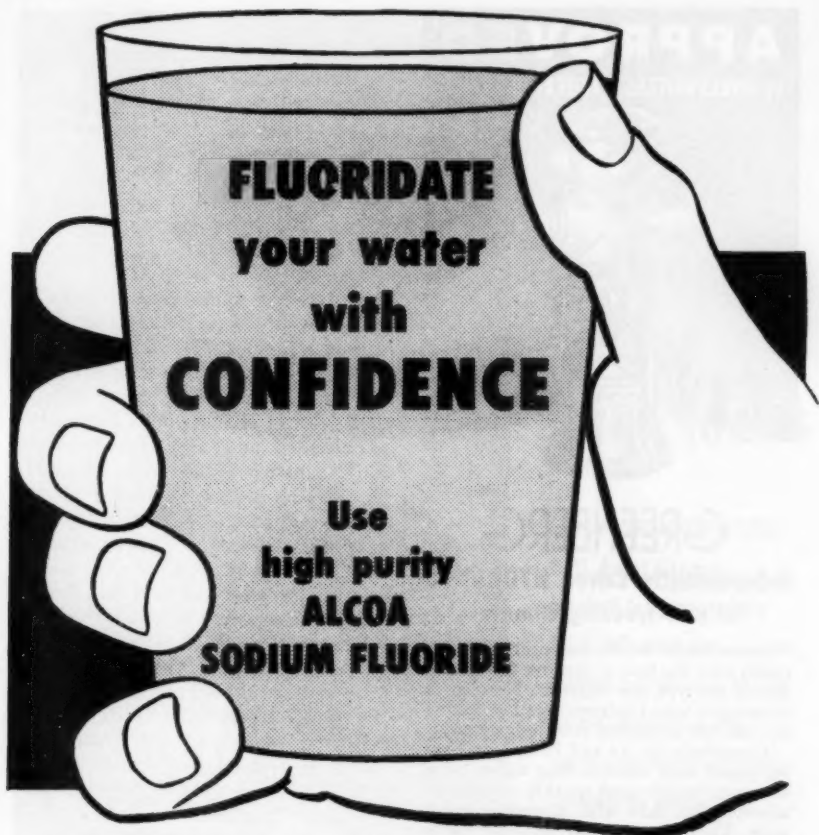
HEADQUARTERS FOR COLORIMETRIC APPARATUS

(Continued from page 40)

on Pt-Co scale, then KMnO_4 soln. was added to oxidize org. material responsible for initial color. It was found by expt. that $n = 0.25 C^\circ$, where n is no. of ml. of $0.01N \text{ KMnO}_4$ soln. and C° is extent of color on Pt-Co scale. In series of water samples, there is no entirely proportional relationship among extent of color, amt. of org. material and magnitude of oxidizability, because of variations in extent of leaching and compn. of org. complexes in water. Larger the excess of KMnO_4 , greater is the oxidizability, because by boiling in presence of org. material, KMnO_4 decomposes spontaneously forming MnO_2 , which causes further decompn., and thus some of its effectiveness as oxidizing agent is lost. "Oxidizability" of distd. water is negligible. Tables of data illustrate relationships found.—C.A.

Application of Flame Spectrophotometry to Water Analysis—Determination of Sodium, Potassium and Calcium. PHILIP W. WEST, PATRICA FOLSE & DEAN MONTGOMERY. *Anal. Chem.*, 22:667 ('50). In theory, introduction of these ions into high-temp. gas flame produces radiations whose intensity is proportional to their concn. Practically, intensity is affected by presence of other cations (also HCO_3^- for Ca). Hence, "emission buffers" similar in principle to those sometimes used in emission spectrography were employed; for Na, water satd. successively with Ca, K and Mg chlorides; for K, with Na, Ca and Mg chlorides; and for Ca, with Na, K and Mg chlorides. Use of these buffers, in proportion of 1 ml. to 25 ml. of sample, renders negligible effect of natural variations in concn. of diverse ions. With Beckman D.U. spectrophotometer and flame unit, standard curves are prepd., with appropriate buffer, for Na, K and Ca at 589, 767 and $556 \text{ m}\mu$, resp. Each calibration point must be corrected for back-

(Continued on page 46)



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(Continued from page 44)

ground luminosity. Practical ranges are 0-100 ppm. for each metal. Unknowns are read with instrument adjusted for sensitivity by means of std. sample, preferably near concn. of unknown cation sought. Results compare well with those of chem. analyses. Higher flame temps. may permit accurate detn. of Mg.—C.A.

The Use of Membrane Filters in Water Analysis. C. R. BAIER. *Vom Wasser*, 17:93 ('49). Use of filtration tests proposed as supplement to customary water analyses. Coarse impurities are collected on paper filter (Schleicher and Schuell No. 589), while colloidal material ($\text{Fe}(\text{OH})_3$, fine clays, plankton) collected in second filtration step on membrane filter of medium porosity. Further sepn. of residue on membrane is possible by soln. and re-pptn. of acid-sol. components. Method is particularly suitable for detn. of Fe by making water sample alk. before filtration, dissolving filter residue in HCl and then carrying out usual colorimetric detn. Time-consuming concn. of water sample by evapn. is avoided and number of ions and sol. org. compds. interfering with test are eliminated in filtration. In waters which contained Fe and Mn in true soln., both could be pptd. in colloidal form by 1-hr. aeration or chlorination.—C.A.

Determination of Trinitrotoluene and Hexanitrodiphenylamine in Water and Industrial Wastes. F. SEIFERT. *Vom Wasser*, 17:89 ('49). Detn. of trinitrotoluene (I) and hexanitrodiphenylamine (II) in plant waste waters and river water is important because of extreme toxicity of these compds. Lethal concn. for fish is 2.0 ppm. for I and 0.15 for II. Sepn. is based on different solubilities of I and II in CHCl_3 and Et_2O . For detn. of I, 100 ml. of water is treated with 20 g. NaCl and 5 ml. of 10%

(Continued on page 48)



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(Continued from page 46)

NH₃, and extd. 3 times with CHCl₃. Filtered and dehydrated ext. is evapd. to dryness and dissolved in 20 ml. acetone. After addn. of 2 ml. of freshly prepd. buffer soln. and 2 ml. of water red color is measured with electrophotometer. For detn. of II, aq. phase of CHCl₃ extn. is shaken out with Et₂O. Combined Et₂O exts. are treated repeatedly with 20% NaCl soln., dehydrated and evapd. Residue is heated to 180° for 1 hr. and taken up with 100 ml. of hot, weakly ammoniacal water. Conc. of II is then detd. colorimetrically.—C.A.

Total Hardness in Water; Stability of Standard Disodium Dihydrogen Ethylenediaminetetraacetate Solutions. CHARLES A. GOETZ, T. C. LOOMIS & HARVEY DIEHL. Anal. Chem., 22:798 ('50). This soln. is

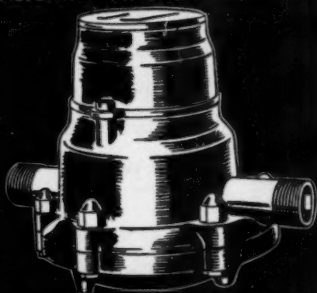
used in Schwarzenbach method for hardness in water [see Jour. A.W. W.A., 42:40 (Jan. '50)]. Standard solns. adjusted to pH values varying from 4.25 to 10.0 and stored in soft-glass bottles were studied over 4-month period. Less than 1% change in strength occurred at pH 4.25–5.0. Recommended pH is obtained when analytical-grade sodium "versenate" is dissolved in distd. water.—C.A.

U.S. WATER SUPPLIES

Surface Water Supply of the United States, 1947. Part 14. Pacific Slope Basins in Oregon and Lower Columbia River Basin. C. G. PAULSEN. U.S.G.S. Wtr. Supply Paper 1094 ('50). Prepared in cooperation with states of Oregon and Washington and other agencies. This volume one of series of 14 reports presenting results

(Continued on page 50)

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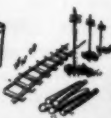
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(Continued from page 48)

of measurements of stage and flow made on streams, lakes and reservoirs in U.S. during water year ending Sept. 30, '47.—P.H.E.A.

Surface Water Supply of the United States, 1947. Part 2. South Atlantic Slope and Eastern Gulf of Mexico Basins. C. G. PAULSEN, U.S.G.S. Wtr. Supply Paper 1082 ('50). Prepared in cooperation with states of Ala., Fla., Ga., La., Miss., N.C., S.C., and Va. and other agencies. This volume part of series of 14 reports presenting results of measurements of stage and flow made on streams, lakes and reservoirs in U.S. during water year ending Sept. 30, '47.—P.H.E.A.

Flow of the Rio Grande and Tributary Contributions. From San Marcial, New Mexico, to the Gulf of Mexico. U.S. & Mexico Intl. Boundary & Water Com. ('48). This bulletin represents 18th compilation of stream discharges and hydrologic data relative to international portion of Rio Grande, prepared jointly by U.S. and Mexican Section of Intl. Boundary & Water Com. Stream flow data and kindred subjects pertain to Rio Grande and its important tributaries near their confluence with main stream from San Marcial, N.M., to Gulf of Mexico. This covers reach from head of Elephant Butte Res. to mouth of river.

Total drainage area within outer rim of Rio Grande Basin is 335,500 sq.mi. However, nearly half of this area yields no runoff to river, productive area of watershed being estimated as 171,900 sq.mi. It is estimated that avg. annual virgin yield from this area was 9,062,000 acre-ft. More than 8,000,000 acre-ft. of storage has been provided to irrigate present total of 2,550,000 acres. Residual flow from Rio Grande that escapes to Gulf of Mexico avgs. 3,500,000 acre-ft.—P.H.E.A.

BACTERIOLOGY

The Survival of a Vi Strain of Typhoid Bacillus and of Its Bacteriophage in Water. A. GUELIN. Ann. Inst. Pasteur, 78:1:78 (Jan. '50). Previous work suggested that absence of typhoid Vi-bacteriophage from water indicated its freedom from typhoid bacilli and that presence of Vi-phage showed that water had been so polluted without necessarily indicating whether typhoid bacilli still present. It was desired to clear up latter point, with use of natural water fully exposed to light and air. Experiments therefore made in pool holding 230 l., fed with water from nearby pond. Vi-phage remained at about initial concentration for 3 weeks and then disappeared slowly but was still detectable after 3 months. Typhoid bacilli, observed in 5-l. quantities of same water, had dis-

(Continued on page 52)

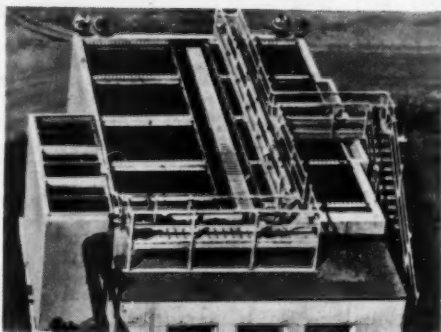
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(Continued from page 50)

appeared in 3 days from surface, but survived 1-2 days longer in deeper parts. It is clear that Vi-phage may be present in water long after typhoid bacilli have disappeared.—B.H.

Estimation of Bacterial Densities by Means of the "Most Probable Number." W. C. COCHRAN. *Biometrics*, 6:105 (June '50). This paper attempts to give simple account of concept of "most probable number" of organisms in dilution method. Dilution method is means for estimating, without any direct count, density of organisms in liquid. It is used principally for obtaining bacterial densities in water and milk. Method consists in taking samples from liquid, incubating each sample in suitable culture medium and observing whether any growth of organism has taken place. Estimation of density is based on ingenious application of theory of probability to certain assumptions. For biologist, it is more important to be clear about these assumptions than about details of mathematics, which are rather intricate.—P.H.E.A.

FLUORIDATION

Use of Fluoride in Drinking Water. HAROLD B. SCALES & PAUL G. BUTLER. *J. Maine Wtr. Util. Assn.*, 25:34 (Mar. '49). Brief, general review of status of fluorides in drinking water

given. Reported that natural fluorides in water at concentration of 1.0 ppm. or greater reduce incidence of dental caries. Authors recommend waiting for outcome of experiments on addition of fluorides artificially to drinking water supplies before mass adoption of this form of treatment for public water supplies. Experiments in progress at this time in dozens of cities throughout country will have to run for several more years before conclusive results are obtained. Several authorities in fields of public health and water supply are quoted with respect to recommendations concerning addition of fluorides to all public water supplies at this time. With one exception, all recommend waiting for results from current experimental programs.—P.H.E.A.

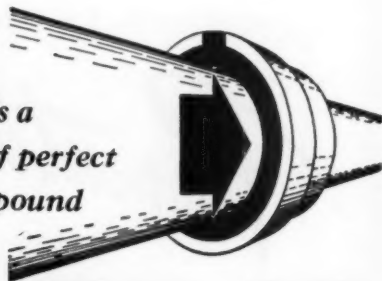
Experience With Fluoridation of Water. WARREN J. SCOTT. *Conn. Health Bul.*, 63:125 (May '49). Four years of operating experience with sodium fluoride treatment of water supply of Southbury State Training School have proved successful. Medical and dental reports indicate marked success in controlling dental decay. No trouble other than initial difficulties with operating equipment has been experienced, and chemical content of water has been uniformly held at desired optimum. No adverse reports of

(Continued on page 54)

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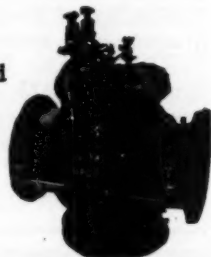


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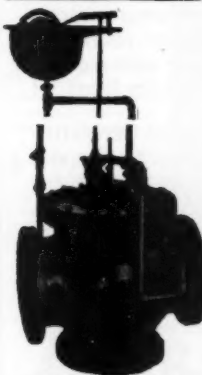
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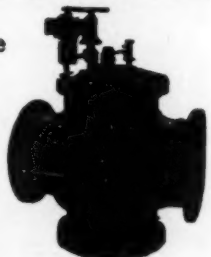


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(Continued from page 52)

any kind have been obtained. Success of treatment is encouraging and process offers definite promise for those communities contemplating it. While other methods of control of dental decay have been used successfully, sodium fluoride treatment of water offers relatively simple method of carrying benefits to entire population in area. On gravity supplies with variable flow, treatment is admittedly more difficult than in supplies equipped with filtration plants or with pumping facilities. However, methods of application for proper proportionate dosage can be worked out.—*P.H.E.A.*

Availability of Fluorine in Sodium Fluoride vs. Sodium Fluosilicate.
F. J. McCLURE. U.S. Pub. Health Repts., 65:37:1175 (Sept. 15, '50). For fluoridation of public water sup-

plies, fluoride can be obtained from sodium fluosilicate for $\frac{1}{3}$ cost of same amt. from sodium fluoride. Toxicologic and physiologic data on sodium fluoride are quite complete. Effects of sodium fluosilicate should be same but never proved. Present study involves measuring fluoride retention in various parts of rats' bodies after period of variable fluoride intake. Fluorides derived from sodium fluoride, sodium fluosilicate and mixed sodium fluoride and sodium silicate. Observed no differences in quant. fluorides deposited in teeth or other parts of bodies, nor in striations produced by higher fluoride concns. Rate of growth normal in both groups. When data are obtained on dental caries effects, substitution of sodium fluosilicate for sodium fluoride may be warranted.—*F. J. Maier*

(Continued on page 56)



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Here's a bible of bark and bite that will enable you to improve both your personnel relations and your public relations. See that every meter reader gets a copy. Make him read it! Make him heed it!

Under the cover reproduced herewith, A.W.W.A. has, in response to the demand of several meter departments, reprinted Bruce McAlister's "Bow-wow, Mister Meterman" as it appeared in

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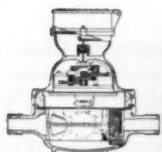
tion of the cost and time required to replace an entire new chamber.

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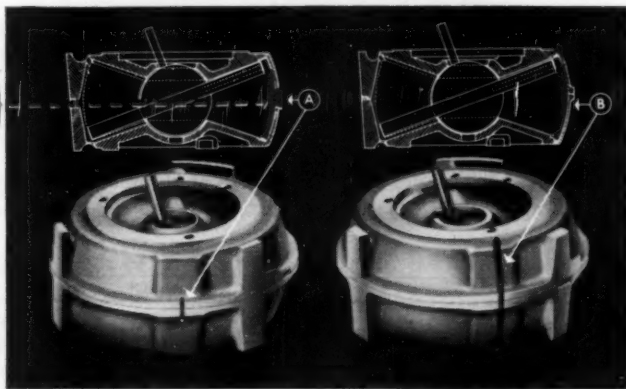
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(Continued from page 54)

WATER QUALITY

Chemistry of Irrigation Water. JUN KOBAYASHI. Nōgaku Kenkyū (Rept. Ohara Inst. Agr. Research), 37:49 ('47). Into 7,350,000 acres of rice paddies in Japan are poured annually through river and lake systems about 100,000 tons K (calcd. as K_2SO_4), 40,000–50,000 N [calcd. as $(NH_4)_2SO_4$] and 1,000,000 tons $CaCO_3$ and silicate, ratio between them varying according to local conditions. Stagnant water of lakes and swamps, subject to following chem. changes, supplies other plant nutrients: surface water in summer is neutral at night but during daytime becomes alk. because equil. $2HCO_3^- \rightleftharpoons H_2O + CO_2 + CO_3^{--}$ proceeds to right by greater consumption of CO_2 by plants for assimilation under influence of light and simultaneously becomes depleted in NH_4 salts, nitrates, phosphates and silicates for building up protein and other constituents of plant body, while deeper layer produces CO_2 , CH_4 , H_2S , PO_4^{--} and NH_3 by oxidative decomn. of dead organisms sedimented from surface and also Fe^{++} and Mn^{++} when bottom mud contains $Fe(OH)_2$ and $Mn(OH)_2$ and thus becomes acidic.—C.A.

The Influence of Seasonal Factors on the Properties of Shore-filtered Rhine Water. G. B. ROEMER. Gesundh.-Ing., 69:44 ('48); Chem. Zentr.

(Russian Zone Ed.) II:645 ('48). Avg. bacterial count of water of Rhine is 6000–8000 per ml. Results of regular tests made in several water works of Düsseldorf in '39–'42 showed that, on avg., this count was reduced far below 100 in soil-filtered water, although at times it suddenly rose to over 1000. Filtering action of soil is lost during winter months as result of death of organisms which destroy bacteria, reduced activity of sludge layer in bottom of river and frequent and sharp variations in height of river. In addn. to high bacterial count, water, as rule, shows pos. coli titer. Chem. data affected by admixt. of true ground water from land. $KMnO_4$ consumption is usually $\frac{1}{3}$ – $\frac{1}{4}$ lower than that of Rhine water. Cl content has risen from earlier values of 30 to 70 ppm. as result of industrial sewage emptied into river. Nitrate content of well water parallels that of Rhine water but is higher than latter as result of oxidation in soil. Reverse is true for nitrite and NH_3 contents.—C.A.

Improving Water Quality by Cleaning Reservoirs and Draining Swamps. MARSHALL S. WELLINGTON. J.N.E. W.W.A., 64:179 (June '50). How 2 reservoirs of New Haven, Conn., Water Co. were cleaned, and large project of draining swamps conducted, is related in this article. First reservoir,

(Continued on page 58)

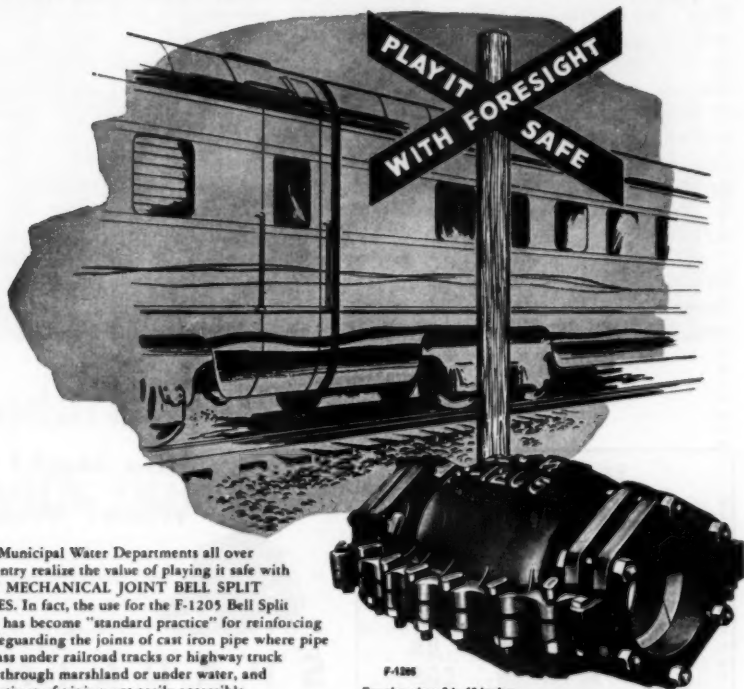
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(Continued from page 56)

over 50 years old, has area of 8.6 acres, with max. depth of 13' of water and avg. of 8'. Depth of muck removed from bottom of reservoir avgd. 4', although in some places it was over 5'. Portion of this muck was topsoil which had not been stripped before reservoir was filled. Cost of removing this muck from reservoir was \$0.80/cu.yd. Second reservoir, also old, had given trouble for many years. How material was removed from reservoirs and disposed of is explained. Treatments used to produce satisfactory water after reservoirs were filled are discussed. Importance of cleaning swamps and manner in which it was done are stressed.—P.H.E.A.

Observations on Water Samples From Cement-Asbestos Pipe Systems in Vermont.

EDWARD L.

TRACEY. J.N.E.W.W.A., 64:164 (June '50). Author emphasizes that complete research project has not been conducted by Vt. Dept. of Health on effect of cement-asbestos pipe on characteristics of water flowing through. This is report of observations made of water characteristics under varying and uncertain conditions of rate of flow through pipes. However, it appears evident that, in small communities, where amount of water consumed is small, and hence rate of circulation is slow, cement-asbestos pipe laid 8-10 yr. ago had considerable effect on pH, hardness and total alkalinity, even when pH of water to start with was above neutral point. It also appears evident that, if enough time is allowed to compensate for low rate of flow, tendency of this older cement-asbestos pipe to raise pH, hardness and total

(Continued on page 60)

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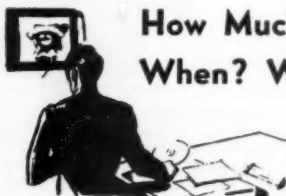
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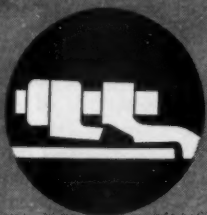
(Continued from page 58)

alkalinity greatly diminishes. Most recent South Burlington and Proctorsville observations point out that newer cement-asbestos pipe has much less tendency to change characteristics of water flowing through it, even though rate of flow be small.—P.H.E.A.

DISINFECTION

Effect of Free and Combined Available Residual Chlorine Upon Bacteria in Swimming Pools. ERIC W. MOOD. *Am. J. Pub. Health*, 40:459 (Apr. '50). This article reports on study pertaining to relative effectiveness of free and combined available residual chlorine as bactericides in swimming pool water. Test organisms used were streptococci and coliforms, both of which grow on tryptone glucose extract agar plates incubated at 35°-37°C. Four swimming pools of continuous-recirculation type were selected as sites for tests. From this study of chlorination of swimming pools, following general conclusions are reached: [1] free available residual chlorine is more effective bactericide than combined available residual chlorine for treatment of swimming pool water; [2] value of 0.4-0.6 ppm. of residual chlorine as recommended by Joint Committee Report, if interpreted to mean free available residual chlorine, will produce bacteriological results that will comply with Joint Committee Report's recommended standards for total number of bacteria and coliform bacteria in swimming pools when in use; [3] min. value of 0.7 ppm. which has been suggested in past for swimming pools using chloramine (combined available residual chlorine) treatment is insufficient to produce bacteriological results, under conditions of this study, which will meet recommended standards of Joint Committee Report; [4] streptococcal bacteria in swimming pools are more resistant to

(Continued on page 62)



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(Continued from page 60)

chlorine than coliform bacteria.—*P.H.E.A.*

Effect of Various Water Ions on the Bactericidal Properties of Quaternaries. E. H. ARMBRUSTER & G. M. RIDENOUR. *Soap*, 25:103 (July '50). Conventional tests of some quaternary ammonium disinfectants were made, by using *Salm. typhi* and adding various concentrations of salts which may be present in ordinary water. Among cations, sodium and potassium had little effect, but calcium and magnesium interfered with bactericidal action considerably, and iron still more so. Anions tested were sulfate, nitrate and chloride, which had little effect, and carbonate and phosphate, which enhanced bactericidal action. Action of calcium salts was confirmed in performance test (killing of *Staph. aureus* dried on glass) with several disinfectants of this type. Further experiments showed that remedy for this loss of efficiency with hard water is addition of alkaline softening agent (sodium carbonate, trisodium phosphate, etc.); efficiency is thus restored to degree obtained with soft water.—*B.H.*

OTHER ARTICLES NOTED

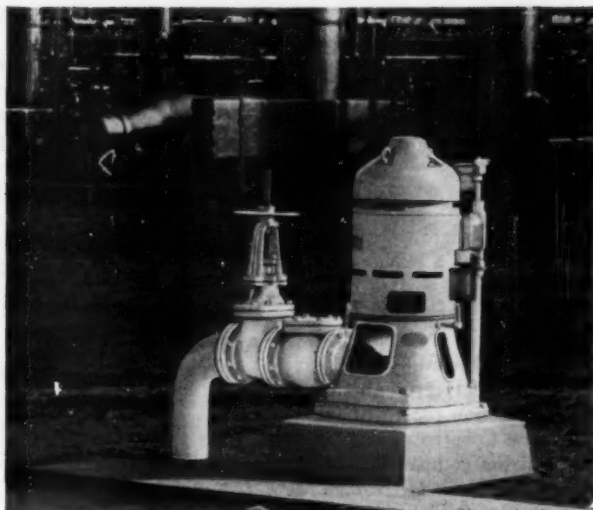
Recent articles of interest, appearing in American periodicals, are listed below.

Hydraulics Simplified. ANON. *Pub. Wks.*, 81:9:58 (Sept. '50).

Surface Potential Method of Corrosion Survey of Pipelines. O. W. WADE. *Corrosion*, 6:341 (Oct. '50).

A New Method for the Protection of Metals Against Pitting, Tuberculation and General Corrosion. H. L. KAHLER & CHARLES GEORGE. *Corrosion*, 6:331 (Oct. '50).

Modern Chlorination Practices. STEWART NEWLAND. *J.N.H.W.W.A.*, 11: 5:3 (Oct. '50).



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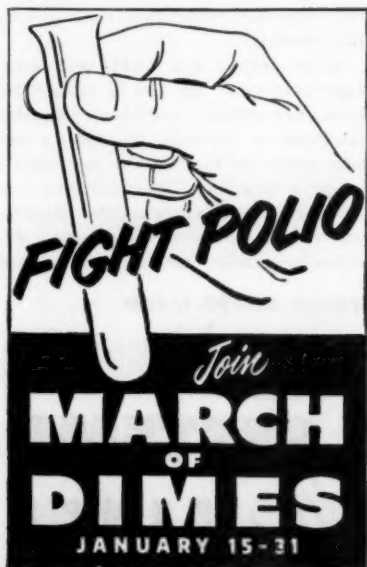


Service Lines

A new vitrified bond for grinding wheels is the subject of a leaflet published by Chicago Wheel & Mfg. Co., 1101 W. Monroe St., Chicago 7, Ill.

"Difficult Construction," a 36-page illustrated booklet, presents the engineering construction record of the Arthur A. Johnson Corp. Copies may be obtained from the company at 347 Madison Ave., New York 17, N.Y.

"Pneumatic Water Works Gauges," an illustrated folder describing metering and control instruments for filtration plants, is being offered as Bul. 285-G1 by Builders-Providence, Inc., 345 Harris Ave., Providence, R.I.



A two-tube midget fluorescent lamp with screw-in base is described in a circular issued by Stocker & Yale, Marblehead, Mass. The unit, which measures $1\frac{1}{2} \times 2 \times 6\frac{1}{2}$ in. and weighs only 14 ounces, comes complete with starter switch, ballast and two 4-w. lamps. Recommended application is for work lights where it offers a source of cool light in close quarters. The "Lite-Mite" operates on alternating or direct current.

A catalog of analytical reagents is available from Mallinckrodt Chemical Works, 2nd & Mallinckrodt Sts., St. Louis 7, Mo. The organization also offers a chart-type outline of the history of chemistry and a table of atomic weights.

"The Story of Duco Finishes" describes the development of du Pont lacquers and paints in the past 30 years. The 20-page booklet may be obtained from the Public Relations Dept., E. I. du Pont de Nemours & Co., Wilmington 98, Del.

A sprocket rim and chain guide to provide floor-based operation of overhead or inaccessible valves or hopper doors is the subject of a folder issued by Babbitt Steam Specialty Co., New Bedford, Mass. Sprocket rims come in a range of 10 adjustable sizes for mounting on all valve types and valve wheel sizes from 2 to 30 in. in diameter.

A guide for the emergency application of Sanitation HTH is being offered in pocket-size form by Mathiesen Chemical Corp., Mathiesen Bldg., Baltimore 3, Md. A dosage nomograph is included.

"Fundamentals of Galvanic Corrosion" is the title of a paper by A. B. Lauderbach. Available in booklet form from Dowell, Inc.

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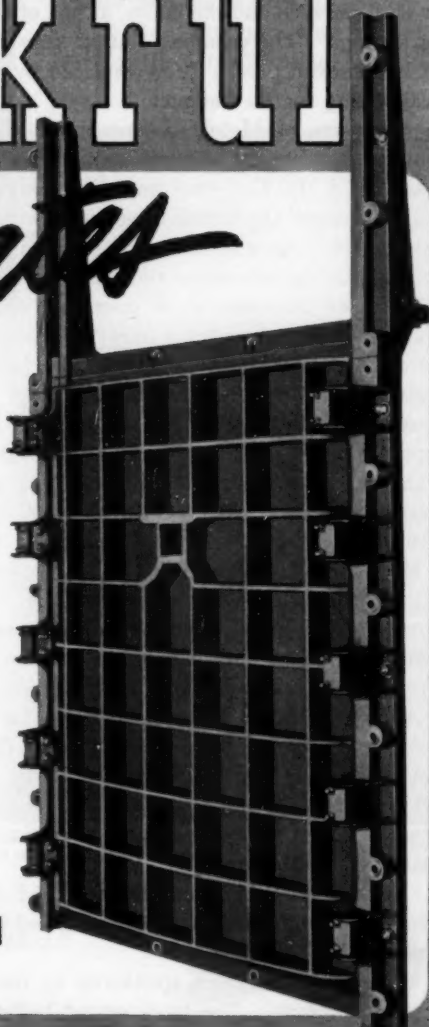
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Write for Catalog 49

(Continued from page 66)

The ladies' program included a luncheon at the renowned Grand Hotel, Point Clear, and a trip to the famous Bellingrath Gardens, as well as a luncheon at Battle House. The ladies were royally entertained by the local ladies' committee. A unique shrimp supper and barbeque was held for both the men and the ladies, at one of the Mobile Water Supply pumping stations. The pumping station, constructed in the early 19th century for large steam pumps (now replaced by small electric pumps), made an ideal setting for the banquet.

The city of Mobile is engaged in the construction of a \$7,000,000 domestic and industrial water supply system. H. E. Myers, principal assistant in J. B. Converse and Co., consulting firm which designed the system, opened the technical sessions with a description of the design of this project. An inspection trip covered the plant of the Lock Joint Pipe Co., pipe laying operations and Mobile's water filtration plant.

Stanley Sweeney, chief operating engineer for the Pensacola, Fla., Water Works, presented a paper, "General Maintenance of Small Water Meters," and a discussion was led by James L. Mattox, manager of the Light and Water Dept., Columbus, Miss. H. D. Shope, of the International Paper Co., Mobile, Ala., discussed "Ground Water, Wells and Water Supply Problems." Tom Collins, manager of the Water Works Board at Ozark, Ala., led the discussion of this paper. "Financing Water Works Construction" was presented by W. L. Gilmer of Polglaze and Basenberg, Birmingham, Ala., and was discussed by George J. Roark, city manager of Meridian, Miss., and Donald Mills, consulting engineer of Selma, Ala. A paper on "Problems in Overloading Distribution Systems" was presented by H. F. Wiedeman of Wiedeman and Singleton, engineers of Atlanta. Discussion was by C. D. Lamon, manager of the Prichard Water Works, and W. U. Quinby, superintendent of water works at Jasper, Ala. L. A. Young, Southeast basin engineer, for the U.S. Public Health Service at Atlanta, presented a paper on "Stream Sanitation in the Southeast Section." This paper was ably discussed by J. C. Clarke, principal sanitary and public health engineer with the Alabama Health Dept. and H. A. Kroeze, director of the Division of Sanitary Engineering, Mississippi Board of Health, Jackson.

Arthur N. Beck, chief engineer and director of the Bureau of Sanitation, Alabama Health Department, led a panel discussion on "Defense Planning."

The cocktail parties sponsored by the manufacturers' representatives were outstanding. The food, served buffet style, was excellent and abundant, and everyone in attendance was well pleased. W. B. Pebworth, chairman of the Entertainment Committee, should be commended for the good time had by all.

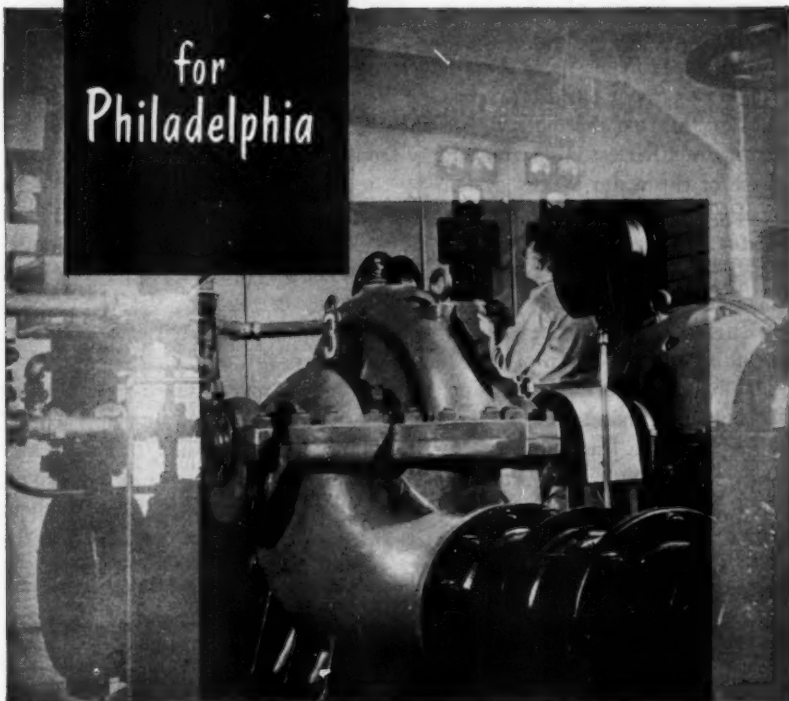
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(Continued on page 70)

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DE LAVAL



(Continued from page 68)

Southeastern Section: The 22nd annual meeting of the Southeastern Section was held in Charleston, S.C., October 23-25, with a total registration of 152. This number included 74 water works and health department personnel and engineers, 47 manufacturers' representatives and 31 ladies, guests of the section.

The meeting was called to order by J. F. Pearson, chairman. The invocation was given by the Rev. F. W. Brandt of Charleston and was followed by an address of welcome by the Honorable William McG. Morrison, mayor of Charleston. The response to the mayor's cordial welcome was given by the chairman.

A paper by F. B. McDowell, manager-engineer of the Commission of Public Works, Charleston, entitled "Improvements to Charleston Water Works," started the morning session. This paper gave an account of the history of Charleston's water supply from its first settlement until the purchase of the water works system by the Commissioners of Public Works in 1917. Following the morning session an inspection of the Charleston Water Works at Hanahan was made. An excellent box luncheon, courtesy of the Public Works Commission and the city of Charleston, preceded a conducted tour of the plant. On returning to the city, the U.S. Corps of Engineers treated the visitors to a boat trip around Charleston Harbor, including an inspection of port facilities.

Tuesday morning's session started with a panel discussion entitled "Troubles, Trials and Tribulations of a Water Works Superintendent," under the able leadership of R. B. Simms, superintendent of the Water Dept. at Spartanburg. Participating in the discussion were Hoyt Baker, W. R. Wise, L. E. Wallis, F. K. Ellis and F. W. Chapman. An excellent paper was then presented by M. T. Thompson, district engineer for the U.S. Geological Survey, on "Water Conservation in the Southeast." A lively discussion followed.

During the business meeting on Tuesday, it was voted unanimously that the annual meeting for 1951 be postponed, and that a joint meeting be held with the national association in Miami. This will afford an opportunity for the section to hold its annual conference in the later winter or early spring of 1952.

Tuesday afternoon's session was started with a panel discussion on "Distribution System Operation and Maintenance Problems." Roy Rugles, superintendent of construction at the Atlanta Water Works, was assisted by Carl C. Lanford and E. B. Adams in the discussion.

Wednesday morning's session started with a paper entitled "Effects of Water Hammer on the Water System" by J. L. Hawkins, superintendent of the Greenville, S.C., Water Dept. Considerable discussion followed, as it appeared that a majority of those in attendance had experienced difficulty at one time and another from excessive water hammer. J. H. Stephens,

(Continued on page 72)

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There's Over A Half-Century of Experience Behind INFILCO Water Conditioning Equipment

WHEN selecting the equipment manufacturer for your new or improved water conditioning plant, you owe it to yourself and your community to investigate the many superior advantages of INFILCO service and equipment.

As pioneer specialists in the design and manufacture of *all* types of equipment for municipal water conditioning plants, Infilco brings unusual skill and long experience to each job. This can mean dollars saved for engineers as well as communities, since many Infilco equipment items perform *multiple* tasks in *space-saving* dimensions, in addition to saving valuable chemicals. Plant operators find Infilco Equipment easy to operate. This is particularly appreciated in smaller communities where water plant budgets cannot afford highly skilled full-time operators.

Investigate *now* the many advantages of specifying INFILCO Water Conditioning Equipment *throughout*. Write our executive offices in Tucson. There's a nearby Infilco Field Engineer with all the facts regarding a complete equipment service.

**SERVING MUNICIPALITIES WITH
WATER CONDITIONING EQUIPMENT THAT'S**

*Quality Engineered for
Quality Performance*

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SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT



**"Big Towns or Small
INFILCO
Serves Them All"**

Send for . .

Bulletin No.
60-C. It illustrates and describes many items of Infilco Equipment.



(Continued from page 70)

director of the Div. of Sanitary Engineering, South Carolina Board of Health, presented an excellent paper on "The Relationship Between the State Board of Health and Public Water Supplies." E. C. Matthews, Macon, Ga., discussed "Increasing the Efficiency of Meter Reading," and emphasized that selling water by meters is the fairest method to all concerned, provided the rates are equitable to all consumers; and that meter installation and reading is a costly operation and one that affects every other phase of water works accounting.

At the annual banquet on Tuesday night, W. T. Linton, director of Stream Pollution Control, South Carolina Board of Health, acted as master of ceremonies. A.W.W.A. Vice-President A. E. Berry urged those present to try to bring into the A.W.W.A. those not now affiliated, so that they too may enjoy the privileges of membership.

T. A. KOLB

Secretary-Treasurer

Virginia Section: The occasion of the seventeenth annual conference of the Virginia Section, held at the Jefferson Hotel, Richmond, on November 6 and 7, will be remembered by the 216 members and guests present as one of the most delightful and informative meetings held by the section. Registration of early arrivals was started on Sunday afternoon prior to the start of the technical sessions on Monday morning. This assured a large attendance at the first session.

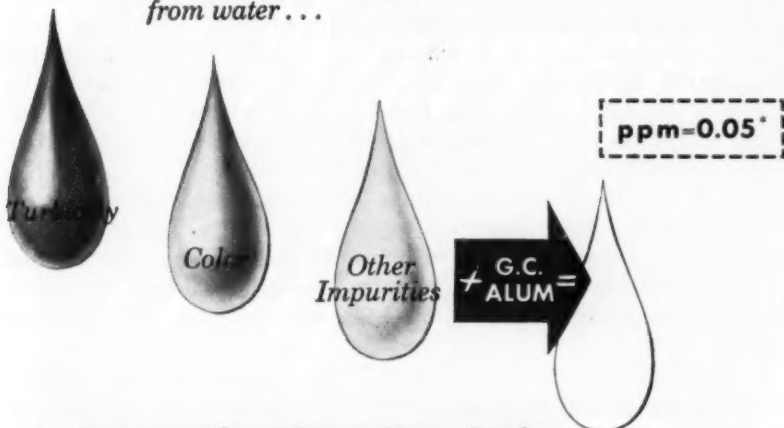
It was most gratifying to observe the large attendance—from 125 to 150—at each of the sessions. Door prizes were given away at each session and undoubtedly helped attract members and guests.

E. C. Meredith, chairman, presided at the open session and welcomed the members and guests. R. S. Phillips, sanitary engineer and superintendent of plants at Charlotte, N.C., opened with a paper entitled "Fluoridation of the Public Water Supply." This paper covered a year's experience in fluoridation at Charlotte. "Civil Defense" was the subject of a discussion by Ed Lordley, assistant director of public utilities at Richmond, who emphasized the need for intensive study of water supply problems arising during time of emergency. Richard Messer, director of engineering, urged that a mutual aid policy be worked out between municipalities and owners of water supplies throughout the state. Considerable discussion resulted, and at the business meeting a resolution was adopted to set up a Civil Defense Committee to approach the Governor's Advisory Committee on Civil Defense and urge that a responsible water works operating man be placed on the state defense organization.

The afternoon session was resumed with a paper on "Unaccounted-for Water" by H. E. Beckwith, district manager for the Pitometer Co., which

(Continued on page 74)

To remove turbidity,
color, other impurities
from water . . .



. . . Here's Why Water Men Prefer

GENERAL CHEMICAL "ALUM"

for COAGULATION

Among water men everywhere, Aluminum Sulfate is the most widely used coagulant for the removal of turbidity, color and similar impurities from water. And with most water men, the choice is *General Chemical Aluminum Sulfate*.

Why?

Because General Chemical "Alum" always offers the same high quality and uniformity . . . always meets the most rigid chemical and physical specifications. And—America over—it is always readily available from General's coast-to-coast network of producing and shipping points. *That's important when emergencies loom.* So be sure—specify General Chemical "Alum" for your operations!

GENERAL CHEMICAL DIVISION ALLIED CHEMICAL & DYE CORPORATION 40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston
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*Many filtration plants produce waters with a turbidity of only 0.05 ppm as a result of effective alum coagulation, efficient settling and filtration.



GENERAL CHEMICAL "ALUM" ADVANTAGES:

- Produces crystal-clear water
- Gives effective floc formation over wide pH and alkalinity conditions
- Insures settling of fine turbidity resulting in longer filter runs
- Helps reduce tastes and odors
- Removes organic color from water
- Has no chlorine demand, because the aluminum ion has no reduced state
- Stores well and remains free-flowing for uniform feeding

(Continued from page 72)

was discussed by S. H. Reaves, superintendent of water and sewage, Winchester, Va.

A.W.W.A. President W. V. Weir gave a most enlightening talk on "The Value of the Water Works Dollar." "Water Department Relations With Other City Departments" was the subject of a talk by R. W. B. Hart, formerly city manager of Lynchburg, Va. Harry A. Faber, research chemist with the Chlorine Institute, New York, presented a paper on "A Summary of Water Chlorination Principles and Practices." The considerable discussion which followed was led by Marsden Smith, chief water engineer for the Dept. of Public Utilities, Richmond.

A. Y. Hyndshaw, research chemist for Industrial Chemical Sales Div., West Virginia Pulp & Paper Co., opened the final session on Tuesday morning with a paper on "Factors Influencing the Efficiency of Activated Carbon." He pointed out that pH value, interfering chlorine compounds and point of application were factors to be considered when using activated carbon.

A public relations panel was headed by W. F. Chapman, town manager of Salem, and proved to be one of the most entertaining of the meeting. Members of the panel included G. H. Ruston, assistant manager of the Roanoke Water Dept., who spoke on "Recreational Use of Watersheds"; H. F. Knoell, town manager of Orange, who discussed "Indoctrination of Personnel Who Deal With the Public"; and Jack Kilpatrick, editor of the *Richmond News-Leader*, who very ably discussed "Taking the Initiative in Keeping Local Press Informed." E. H. Ruehl, engineer of R. Stuart Royer & Associates, Richmond, spoke on "Presenting the Water Works Story to Local Clubs."

Entertainment features included a dance and floor show, the latter a presentation of the Arthur Murray Dancers, the theme being the Cavalcade of Dance. The annual banquet was held on Monday night and also preceded the dance and floor show.

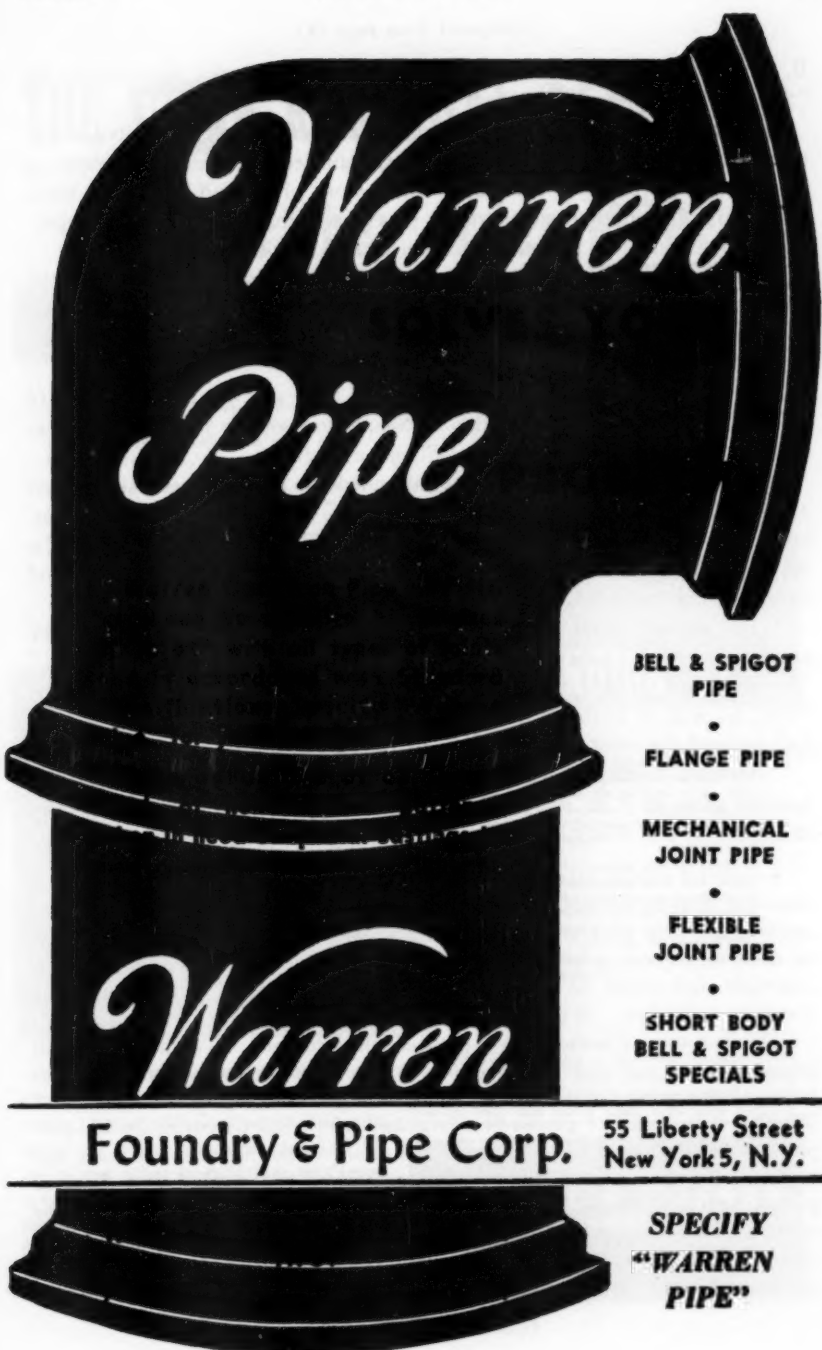
An inspection trip was arranged to visit Richmond's new water filtration plant which was dedicated in March of this year.

W. H. SHEWBRIDGE
Secretary-Treasurer

Cuban-Florida Sections: The regular fall meeting of the Florida Section was held, jointly with the Cuban Section and the Florida Sewage Works Association, at the Governors' Club Hotel in Fort Lauderdale, Fla. There were 216 members and guests registered at this meeting, which was held November 12-15.

The opening session on Monday morning was presided over by the Florida Section Chairman S. K. Keller, and was highlighted by a report from Secretary Jordan on "Activities of the A.W.W.A." and a report by

(Continued on page 76)



Warren Pipe

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FLEXIBLE
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SPECIFY

**"WARREN
PIPE"**

(Continued from page 74)

B. F. Borden Jr., director of the Florida Sewage Works Association, on "Sewage Federation Activities."

Laurence H. Daniel, secretary of the Cuban Section, presented a historical paper covering the history of the Cuban Section, which is celebrating its Tenth Anniversary. His paper was a work of art and one of the main highlights of the entire meeting. A paper on Cuban water rates was presented by Manuel J. Puente, chairman of that section.

Panel discussions led by David B. Lee, national director from the Florida Section; S. W. Wells, chairman-elect of the Florida Section; and A. P. Black, past-president of A.W.W.A., were all enthusiastically participated in by the audience.

Papers were also presented by Linn H. Enslow, past-president of A.W.W.A.; Harry Gehm of the National Council for Stream Improvement; and Harry E. Faber of the Chlorine Institute.

The luncheon on Monday was attended by 160 members and guests and terminated with a very fine address by J. Frank Rushton of Jacksonville entitled "The Twilight's Last Gleaming." On Monday evening the sections were guests of the city of Fort Lauderdale at a buffet supper and dance held at the Bahia-Mar Yacht Club.

The annual banquet was also held at the Yacht Club and featured the announcement of a new membership award, the "Alvin Percy Black Cup." The awarding of this beautiful cup came as a complete surprise to Dr. Black, as well as to the first awardee, D. W. Jones, of North Miami, who had secured the most new members for the section during the year.

Another highlight of the banquet was the presentation of a box of hominy grits to A.W.W.A. Secretary Harry Jordan. These grits were presented by Dr. Black, the substance of whose remarks follows:

Successful men do many things well. Most of them have a hobby, or avocation—call it what you will—to provide stimulating activity after the work of the day is done. Our guest of honor has such a hobby. It is cooking, and I am told by those who claim to know that he slings a skillful spoon. But there is one delectable dish which he has never learned to prepare and, what is infinitely worse, to appreciate. It is *grits*.

This is a serious matter, which gives me deep concern. I would remind our genial secretary and erstwhile cook that the true gourmet knows well the importance of the proper frame of mind to the highest enjoyment of any food. Whether it be breast of guinea hen garnished with truffles from Spain and prepared with loving care by Oscar of the Waldorf (who died just one week ago today), or a pearly mound of creamy, snow-white grits bathed in a flood of golden butter, it should be consumed slowly, reverently, remembering all the while winter's biting cold and the heat of summer's sun; the gentle rain and the driving wind; the rich, warm soil and the labors of many men: all of which conspired together to give it birth.

(Continued on page 78)

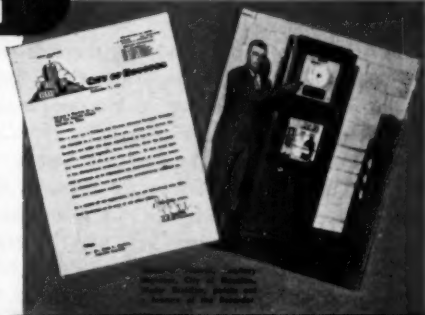
THE **W&T** RESIDUAL RECORDER

so good they order MORE..

at HOUSTON, TEXAS

where a W&T Residual Recorder was installed on a trial basis and for several months put through a series of rigorous, exacting tests at six of the Houston Water Plants.

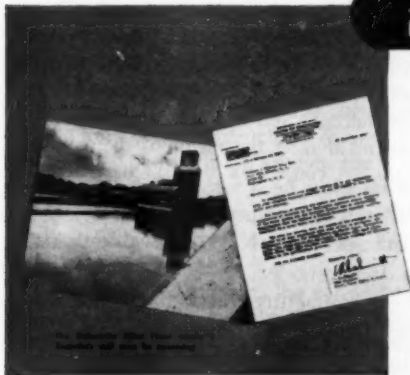
The performance of the Recorder in these tests is described by Mr. E. N. Baldwin, Director of Utilities, who writes in a recent letter "....We have found that it eliminates the inaccuracies associated with all colorimetric tests and provides automatically recorded results for permanent records. As a result of our experience, we are now installing four Residual Recorders at as many of our water plants."



at WASHINGTON, D.C.

At the 85 mgd Dalecarlia Filter Plant serving the nation's capital, a W&T Residual Recorder was installed to measure the residual of the filter effluent. The results were so effective that Mr. E. A. Schmitt, Head Engineer, Chief of the Water Supply Division writes:

"....The need for knowing that the health of the consumer is safeguarded is of such importance that this office is purchasing six additional recorders for installation at its 85 mgd Dalecarlia rapid sand plant and at the 100 mgd McMillan slow sand plant. These units will give chlorine residual sample readings at strategic points in the purification process."



All the advantages of residual recording such as improved chlorine usage, better chlorination control and smoother plant operation typified by these and other installations at Cleveland, Richmond, Kansas City, and Atlanta can be obtained for your plant too. Just call your nearest W&T Representative for full details today.

For precision feeding of treatment chemicals use the W&T Merchon Scale Feeder—handles from ounces to tons per minute, uses a constant speed weigh belt, and has a screw type feed section.

WALLACE & TIERNAN

COMPANY, INC.

CHICAGO AND NEW YORK OFFICES
NEWARK, NEW JERSEY REPRESENTED IN PRINCIPAL CITIES

(Continued from page 76)

Grits is of the South—we say it proudly! It is the fruit of the wedding of water and carbon dioxide, by an alchemy which only Nature knows, in firm, ripe ears of corn. You will find it on your breakfast plate in the Emerald Room of the beautiful Peabody Hotel in Memphis, pride of all the Southland, drenched with a savory sauce of tomato and cheese. Or, if you are *very* fortunate, you will find it on a plain pine table in a little southern cabin, with pickaninnies playing 'round the door and a mocking bird in a giant magnolia singing his heart out to a full moon rising through fragrant pines. But, wherever you find it, remember this, and mark it well. Of such stuff are heroes made, for grits, and little else, sustained Lee's tattered armies as they made their gallant stands at Gettysburg and Antietam.

In its concentrated goodness, there is the story of proud and resolute men and women who have transformed the Southland. In it you will find the song of the plow, the harmony of blended voices in fields white with cotton, the whisper of a breeze through sighing pines, the crash and roar of cannon, and the sobs of women in the ruins of homes laid desolate by war. But you will find, too, the prayers of men for courage, the ring of the woodsman's axe, the lowing of cattle, the whir of the loom, the confused cadences of great cities, the sweet chimes of church bells and the happy laughter of little children.

It is such stuff as dreams are made of, for where else came the vibrant grace and radiant beauty of southern womanhood, of which poets have sung so sweetly and so well?

And so I hand you this container, especially made for you, filled with Florida grits especially ground for you. Take it back with you to the man-made canyons of the city and when cold winter winds are blowing and snow flies outside the window, serve it in the warmth and comfort of your home. With it goes our hope that, as its distilled and concentrated sunlight suffuses you with a sense of physical well-being, so also may the warm and abiding friendship of the members of the Florida Section strengthen and support you in the difficult days that lie ahead.

After such an effusive and beautiful speech, it is inconceivable that the grits could ever end their career in a double boiler.

A club room was provided by the manufacturers under the able management of Tom Finley, Frank Brooks and Henry Perkerson.

The facilities provided by the Governors' Club Hotel for the lounge, meeting rooms, and club room were perfect, the Governors' Club having set aside the entire second floor for the use of the meeting.

M. R. BOYCE
Secretary-Treasurer

Chesapeake Section: The second annual meeting of the Chesapeake Section was held in Wilmington, Del., November 1-3. There was a total registration of 169 which included water works personnel, manufacturers representatives and all registered guests.

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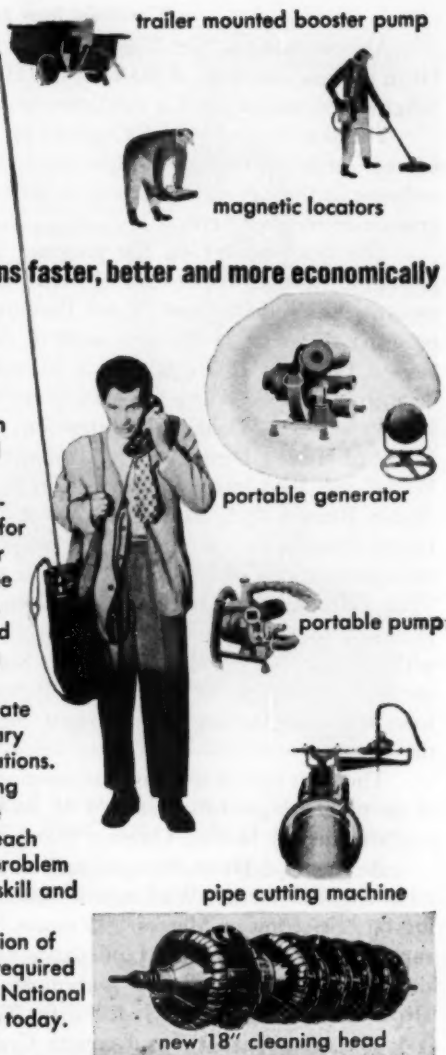
**all this
and
radio
too,**

helps NATIONAL clean water mains faster, better and more economically

The highly specialized equipment employed by the National Water Main Cleaning Co. today includes: walkie-talkie radio systems for maintaining constant communication between the point of operation and control valves or pumping stations, magnetic locators for tracing underground pipe, truck-mounted pumps for dewatering, trailer-mounted booster pumps for stepping-up pressure, pipe cutting machines and a tremendous variety of cleaning heads developed to meet the requirements of varying pipe sizes, conditions and layouts.

Even more important than adequate equipment is the experience necessary to cope with all conditions and situations. The nature of the obstruction, varying pipe sizes, unusual pipe layouts, the character of the water — all make each cleaning assignment an individual problem calling for specialized experience, skill and equipment.

We'll be glad to check the condition of your water mains, recommend the required treatment and estimate the cost of National Water Main Cleaning service. Write today.



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As customary, a "Get-Together" was held on the evening of November 1st in the spacious halls of the Du Pont Hotel, where new and old members congregated and enjoyed a social evening with light refreshments.

The session was officially opened on Thursday morning as Chairman Clarke Gardner introduced Mayor James F. Hearn, who extended a cordial welcome to the city. Together with the beautiful weather, the section was graciously received here.

The first speaker on the program was Robert R. Bennett, district geologist, Ground Water Branch, U.S. Geological Survey, who opened a two-man panel on Ground Water Resources of the Chesapeake Bay Area, covering that part of the area west of the bay. William C. Rasmussen, also of U.S.G.S., followed with a discussion of the area east of the bay. "Control of Public Water Supplies by the Delaware State Board of Health" was presented by Donald K. Harmeson, director, Div. of Sanitation, State Board of Health, Dover, Del. A lengthy and interesting panel on "Water Wells" was then introduced by Albert G. Fiedler, assistant chief, Ground Water Branch, U.S. Geological Survey. Paul Schweitzer, president of Layne-Atlantic Co., and Henry A. Gropp, also of this firm, followed with the special topics of "The Development of a Ground Water Supply" and "The Selection and Description of Deep Well Pumps." John C. Geyer, professor of sanitary engineering at Johns Hopkins University, continued with "Water Well Abuse" and W. J. Sloan, of E. I. DuPont de Nemours and Co., concluded the panel with "Rehabilitation of Wells." This panel was very enlightening and brought forth considerable discussion from the floor.

The high spot of the business meeting was a carefully prepared résumé of the proceedings of the last A.W.W.A. Board of Directors meeting which was attended by Section Director Harry Shaw.

A "General Meter Symposium" was begun with John Jester, department engineer for the Washington Suburban Sanitary Commission, speaking on "Selection of Meters." Francis W. Buschman, principal assistant superintendent of Meter Maintenance and Operations, treated "Installation and Maintenance," and Marvin W. McKay, registrar of the Water Dept. at Wilmington, concluded with "Billing and Reading Meters."

The next speaker was Kenneth C. Carl, engineer with the National Board of Fire Underwriters, who spoke on "Adequacy and Reliability in Water Supply Systems From the Fire Protection Standpoint." A panel on "Air Conditioning Demands" was then opened by R. C. Willson, superintendent of the Water Dept. at Hagerstown, Md., who gave a brief summation. Harry Shaw, deputy chief engineer of the Washington Suburban Sanitary Commission, presented the experience of the sanitary commission and cited some advancements in the work with examples of savings in water consumption. Karl H. Shamberger Jr., associate engineer of the Bureau

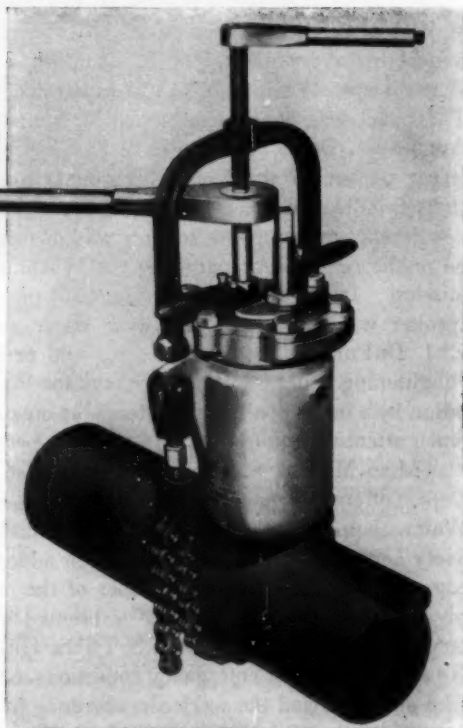
(Continued on page 82)

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FOR THE MAN
IN THE DITCH**



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TAPPING
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**FOR INSERTING ALL
STANDARD MAKES OF
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FASTER . . . Less time required to make a tap • Two ratchet wrenches speed up operations • Head turns freely at all pressures

EASIER HANDLING . . . Shorter height • More rigid attachment to the main • More room in the ditch • Fewer operations—less physical effort required

EFFICIENT . . . Machine fully loaded, ready for operation before placing on the main • No disassembling to insert corporation stop • Flat link chain—positive grip on main

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HAYS MODEL B
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ECONOMICAL . . . Longer life of tools—more taps per tool • Renewable bearings and working parts • Designed to use short pattern taps and screw plugs



COPPER BRASS LEAD IRON
WATER WORKS PRODUCTS
HAYS MANUFACTURING CO., ERIE, PA.

(Continued from page 80)

of Water, Baltimore, then reviewed Baltimore's problems in getting customers to save water. Roy L. Orndorff, assistant superintendent of the Water Dept., Washington, D.C., illustrated his outline with lantern slides. The panel was concluded by R. A. Gonzalez, manager of the Products Application Dept., Airtemp Div., Chrysler Corp., who gave a slightly different picture of the whole situation, citing the city of Akron, Ohio, a strictly industrial area. A very lively discussion followed the panel.

Friday morning the session was opened as usual with a movie—one on public relations prepared by the Washington Suburban Sanitary Commission. It was a very interesting color picture and well edited. The first speaker was Edward B. Showell, water and trade waste consultant for E. I. DuPont de Nemours & Co., who presented a most interesting and enlightening paper on "Ion Exchange for Water Treatment." The presentation by a novel projection system was outstanding, and the paper received much attention and discussion.

Miss Miriam S. Shane, bacteriologist with the Wilmington Water Dept., offered a paper entitled "Medical Bacteriology, or Interpreting Water Supply to the Public." Her valuable paper brought forth some lively and interesting discussion which added much to our store of knowledge in this field. The final paper of the meeting was on "Civil Defense Significance to Water Systems" presented by Gordon E. McCallum, sanitary engineer director of the U.S. Public Health Service, Washington, D.C. He stressed present emergency conditions, outlined what plans are in existence and reviewed the work already done in the District of Columbia.

The annual banquet was held on Thursday evening in the lovely and spacious Gold Ballroom, being preceded by a cocktail hour in the Du Barry Room. This cocktail hour was a part of the Club Room system which we find so successful at our Chesapeake Section, and was made possible through the courtesy of the Water & Sewage Works Manufacturers Assn.

Special tours of water plants at the Sinclair Oil Plant at Marcus Hook and the Scott Paper Co. of Chester and the Wilmington water supply were provided on Friday afternoon, guests going by bus to these localities. Special provision for the ladies was also provided by a committee headed by Mrs. Edward B. Showell. It consisted of a trip to the beautiful DuPont Longwood Gardens in Kennett Square on Thursday morning, followed by a luncheon at the DuPont Country Club. The ladies were also treated with a special Fabric Exhibit in the Nemours Building where all sorts of nylon fabrics were on display. Golf was also available to those who cared to enter, and it was not overlooked by the faithful. The meeting, while not as large as might have been expected in Baltimore or Washington, was highly successful in bringing out many new faces from our host state of Delaware.

C. J. LAUTER
Secretary-Treasurer

The inside story of "Century" ASBESTOS-CEMENT PIPE

BEFORE you specify pipe for water mains, be sure to consider the *inside*, as well as the outside. Here's what you'll find inside "Century" Asbestos-Cement Pipe:

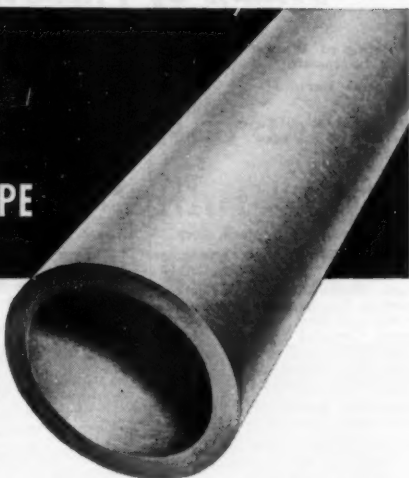
A SMOOTH, CLEAN BORE THAT STAYS THAT WAY!—"Century" Asbestos-Cement Pipe is formed on a smooth, steel mandrel—the pipe's interior takes its surface from this... permanently smooth! (Williams and Hazen Constant "C" is conservatively placed at 140 for "Century" Asbestos-Cement Pipe).

A NON-TUBERCULATING SURFACE! Tuberculation, one of the pipe enemies from within, first increases friction, then reduces flow area. This cannot happen with "Century" Asbestos-Cement Pipe. It is entirely non-metallic. Initial flow capacity remains constant!

A SURFACE THAT RESISTS CORROSION! Though corrosion is usually an *external* enemy of pipe, certain combinations of water chemicals,



Installation crew laying "Century" Pipe through wooded area.



together with electrolysis, can bring about internal pipe corrosion and deterioration. "Century" Asbestos-Cement Pipe is entirely mineral in nature—is immune to electrolysis—resists all corrosion factors, both internal and external!

AND CONSIDER THE OTHER FEATURES OF "CENTURY" ASBESTOS-CEMENT PIPE: "Century" Pipe is exceptionally strong, yet, light in weight. It can be handled easily, laid quickly, without special laying equipment. The "Century" Simplex Couplings are of the same Asbestos and Cement composition as the pipe—permit rapid, easy laying of both straight runs and curves up to 5° deflection per pipe length. And, so permanently strong and unchanging is "Century" Pipe, that it can be recovered and laid in its original pressure class!

BEFORE YOU BUY OR SPECIFY ANY PIPE FOR WATER MAINS, get the complete story on Keasbey & Mattison "Century" Asbestos-Cement Pipe. We'll gladly send details upon request.

Nature made Asbestos...

Keasbey & Mattison
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since 1873



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Flexible Underground Pipe Clean-

ing Co.

National Water Main Cleaning Co.

Compressors, Portable:

Worthington Pump & Mach. Corp.

Condensers:

United States Pipe & Foundry Co.

Contractors, Water Supply:

Boyce Co., Inc.

Layne & Bowler, Inc.

Controllers, Liquid Level,

Rate of Flow:

Builders-Providence, Inc.

Inflico, Inc.

Simplex Valve & Meter Co.

R. W. Sparling

Copper Sheets:

American Brass Co.

Copper Sulfate:

General Chemical Div.

Tennessee Corp.

Corrosion Control:

Calgon, Inc.

Dearborn Chemical Co.

Couplings, Flexible:

DeLaval Steam Turbine Co.

Dresser Mfg. Div.

Philadelphia Gear Works, Inc.

Smith-Blair, Inc.

Diaphragms, Pump:

Dorr Co.

Morse Bros. Mchy. Co.

Proportioners, Inc.

Engines, Hydraulic:

Ross Valve Mfg. Co.

Engineers and Chemists:

(See Prof. Services, pp. 25-29)

Feedwater Treatment:

Calgon, Inc.

Cochrane Corp.

Dearborn Chemical Co.

Graver Water Conditioning Co.

Hungerford & Terry, Inc.

Inflico, Inc.

Ferrie Sulfate:

Tennessee Corp.

Filter Materials:

Johns-Manville Corp.

Inflico, Inc.

Northern Gravel Co.

Filters, Incl. Feedwater:

Cochrane Corp.

Dorr Co.

Everson Mfg. Corp.

Inflico, Inc.

Morse Bros. Mchy. Co.

Permutit Co.

Roberts Filter Mfg. Co.

Ross Valve Mfg. Co.

Filtration Plant Equipment:

Builders-Providence, Inc.

Chain Belt Co.

Cochrane Corp.

Graver Water Conditioning Co.

Hungerford & Terry, Inc.

Inflico, Inc.

Omega Machine Co. (Div., Build-

ers Iron Fdry.)

Roberts Filter Mfg. Co.

Stuart Corp.

Welsbach Corp., Ozone Processes

Div.

Fittings, Copper Pipe:

Dresser Mfg. Div.

M. Greenberg's Sons

Hays Mfg. Co.

James Jones Co.

A. P. Smith Mfg. Co.

Fittings, Tees, Elbs, etc.:

Cast Iron Pipe Research Assn.

James B. Clow & Sons

Dresser Mfg. Div.

James Jones Co.

Kennedy Valve Mfg. Co.

M & H Valve & Fittings Co.

United States Pipe & Foundry Co.

Warren Foundry & Pipe Corp.

R. D. Wood Co.

Flocculating Equipment:

Chain Belt Co.

Cochrane Corp.

Dorr Co.

Inflico, Inc.

Stuart Corp.

Walker Process Equipment, Inc.

Fluoride Chemicals:

Aluminum Co. of America, Chemi-

cals Div.

Blockson Chemical Co.

Furnaces:

Jos. G. Pollard Co., Inc.

Furnaces, Joint Compound:

Northrop & Co., Inc.

Gages, Liquid Level:

Builders-Providence, Inc.

Inflico, Inc.

Simplex Valve & Meter Co.

Gages, Loss of Head, Rate of

Flow, Sand Expansion:

Builders-Providence, Inc.

Inflico, Inc.

Northrop & Co., Inc.

Simplex Valve & Meter Co.

R. W. Sparling

Gasholders:

Chicago Bridge & Iron Co.

Pittsburgh-Des Moines Steel Co.

Gaskets, Rubber Packing:

Northrop & Co., Inc.

Smith-Blair, Inc.

Gates, Shear and Stulce:

Armco Drainage & Metal Products,

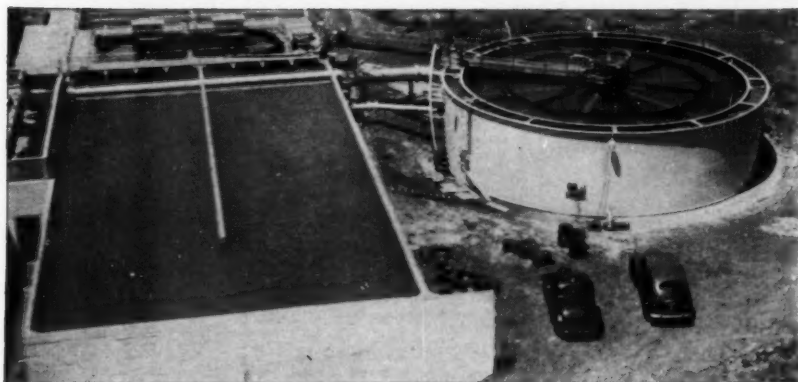
Inc.

Morse Bros. Mchy. Co.

R. D. Wood Co.

CLEARER WATER

obtained in **LESS SPACE** and at
LOWER COST with this
GRAVER REACTIVATOR



The accompanying photograph shows a Graver Reactivator installed alongside a conventional rectangular treating tank for the water supply of a West Coast municipality.

The two units have the same capacity—but notice the far smaller size of the circular GRAVER unit.

And this saving in space is only one of the GRAVER advantages. With initial raw water turbidity varying between 50 and 200 ppm, the smaller GRAVER unit produces an effluent with only 4.5 ppm turbidity . . . less than half that of the effluent from

the larger conventional unit, and with no greater cost of chemicals.

The Engineer operating this equipment writes: "*You are to be congratulated on having a piece of equipment that really can live up to its expectations.*"

To be sure of dependable results in treating your water supply, such as those obtained at this plant, investigate GRAVER Reactivators. Write for complete information. GRAVER recommendations are based on 40 years of specialized experience in solving Water Treatment problems.

□ W 400

GRAVER WATER CONDITIONING CO.

216 West 14th Street, New York 11, New York, U.S.A.
CHICAGO • PHILADELPHIA • CLEVELAND



A DIVISION OF GRAVER TANK & MFG. CO., INC. EAST CHICAGO, IND.

Gears, Speed Reducing:

DeLaval Steam Turbine Co.
Philadelphia Gear Works, Inc.

Glass Standards—Colorimetric**Analysis Equipment:**

Hellige, Inc.
Klett Mfg. Co.
Wallace & Tiernan Co., Inc.

Goose-necks (with or without**Corporation Stops):**

Hays Mfg. Co.
James Jones Co.
A. P. Smith Mfg. Co.

Hydrants:

James B. Clow & Sons
M. Greenberg's Sons
James Jones Co.
Kennedy Valve Mfg. Co.
John C. Kupferle Foundry Co.
Ludlow Valve Mfg. Co.
M & H Valve & Fittings Co.
A. P. Smith Mfg. Co.
Rensselaer Valve Co.
Ross Valve Mfg. Co.
R. D. Wood Co.

Hydrogen Ion Equipment:

Hellige, Inc.
Wallace & Tiernan Co., Inc.

Ion Exchange Materials:

Cochrane Corp.
Hungerford & Terry, Inc.
Inflico, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Rohm & Haas Co.

Iron Removal Plants:

American Well Works
Chain Belt Co.
Cochrane Corp.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Inflico, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.
Welsbach Corp., Ozone Processes Div.

Jointing Materials:

Atlas Mineral Products Co.
Michael Hayman & Co., Inc.
Hydraulic Development Corp.
Leadite Co., Inc.
Northrop & Co., Inc.

Joints, Mechanical, Pipe:

Carson-Cadillac Co.
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
Dresser Mfg. Div.
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Laboratory Reagents:

Ohio Research & Testing Labs.

Leak Detectors:

Jos. G. Pollard Co., Inc.

Lime Slakers and Feeders:

Dorr Co.
Inflico, Inc.
Omega Machine Co. (Div., Builders Iron Fdry.)

Magnesium Anodes (Corrosion**Control):**

Dowell Incorporated

Manometers, Rate of Flow:

Builders-Providence, Inc.

Motor Boxes:

Art Concrete Works
Ford Meter Box Co.
Pittsburgh Equitable Meter Div.

Meter Couplings and Yokes:

Badger Meter Mfg. Co.
Dresser Mfg. Div.
Ford Meter Box Co.
Hays Mfg. Co.
Hersey Mfg. Co.
James Jones Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Smith-Blair, Inc.
Worthington-Gamon Meter Co.

Meter Reading and Record**Books:**

Badger Meter Mfg. Co.

Meter Testers:

Badger Meter Mfg. Co.
Ford Meter Box Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.

Meters, Domestic:

Badger Meter Mfg. Co.
Buffalo Meter Co.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Meters, Filtration Plant,**Pumping Station,****Transmission Line:**

Builders-Providence, Inc.
Inflico, Inc.
Simplex Valve & Meter Co.
R. W. Sparling

Meters, Industrial, Commercial:

Badger Meter Mfg. Co.
Buffalo Meter Co.
Builders-Providence, Inc.
Hersey Mfg. Co.
Neptune Meter Co.
Pittsburgh Equitable Meter Div.
Simplex Valve & Meter Co.
R. W. Sparling
Well Machinery & Supply Co.
Worthington-Gamon Meter Co.

Mixing Equipment:

Chain Belt Co.
Inflico, Inc.
Walker Process Equipment, Inc.

Ozonation Equipment:

Welsbach Corp., Ozone Processes Div.

Pipe, Asbestos-Cement:

Johns-Manville Corp.
Kearsey & Mattison Co.

Pipe, Brass:

American Brass Co.

Pipe, Cast Iron (and Fittings):

American Cast Iron Pipe Co.
Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Pipe, Cement Lined:

Cast Iron Pipe Research Assn.
Central Foundry Co.
James B. Clow & Sons
United States Pipe & Foundry Co.
Warren Foundry & Pipe Corp.
R. D. Wood Co.

Pipe Coatings and Linings:

The Barrett Div.
Cast Iron Pipe Research Assn.
Centriline Corp.
Dearborn Chemical Co.
Koppers Co., Inc.
Warren Foundry & Pipe Corp.

Pipe, Concrete:

American Pipe & Construction Co.
Lock Joint Pipe Co.
Price Bros. Co.

Pipe, Copper:

American Brass Co.

Pipe Cutting Machines:

Ellis & Ford Mfg. Co.
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.

Pipe Jointing Materials; see**Jointing Materials****Pipe Locators:**

Jos. G. Pollard Co., Inc.

Pipe, Plastic:

Carlton Products Corp.

Pipe, Steel:

Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co.

Pipelines, Submerged:

Boyce Co., Inc.

Plugs, Removable:

James B. Clow & Sons
Jos. G. Pollard Co., Inc.
A. P. Smith Mfg. Co.
Warren Foundry & Pipe Corp.

Potentiometers:

Hellige, Inc.

Pressure Regulators:

Ross Valve Mfg. Co.

Pumps, Boiler Feed:

DeLaval Steam Turbine Co.
Peerless Pump Div., Food Machinery Corp.

Pumps, Centrifugal:

American Well Works
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Morse Bros. Mch. Co.
Peerless Pump Div., Food Machinery Corp.

Pumps, Chemical Feed:

Inflico, Inc.
Proportioners, Inc.
Wallace & Tiernan Co., Inc.

Pumps, Deep Well:

American Well Works
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery Corp.
Worthington Pump & Mach. Corp.

Pumps, Diaphragm:

Dorr Co.
Morse Bros. Mch. Co.
Proportioners, Inc.

Pumps, Hydrant:

Jos. G. Pollard Co., Inc.

Pumps, Hydraulic Booster:

Ross Valve Mfg. Co.

Pumps, Sewage:

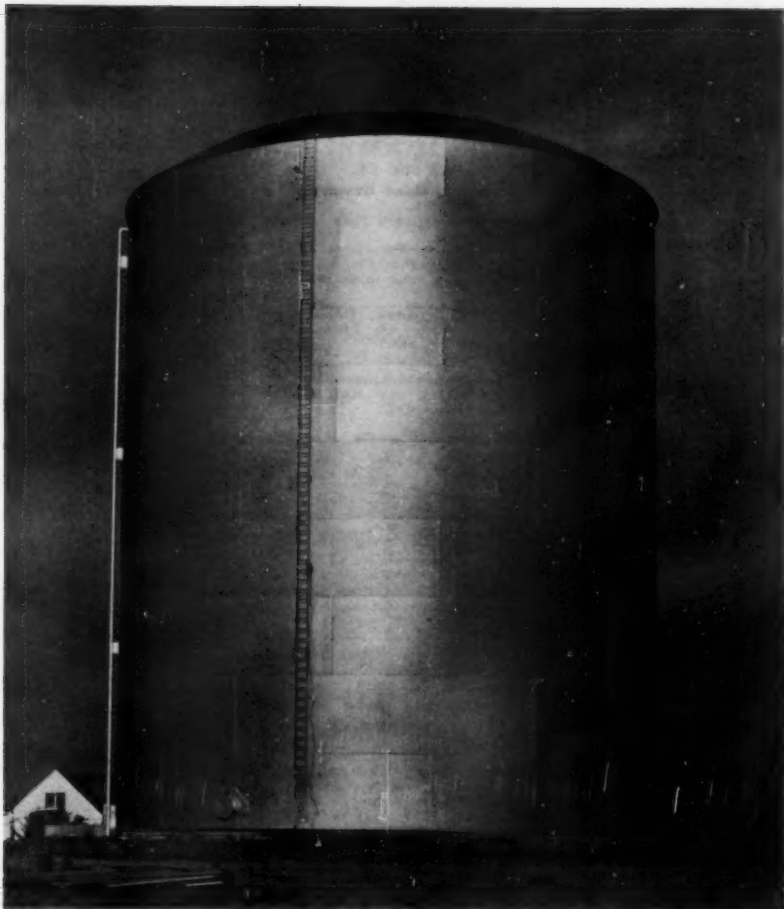
DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Peerless Pump Div., Food Machinery Corp.

Pumps, Sump:

DeLaval Steam Turbine Co.
Economy Pumps, Inc.
Peerless Pump Div., Food Machinery Corp.

Pumps, Turbine:

DeLaval Steam Turbine Co.
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery Corp.
Worthington Pump & Mach. Corp.



Horton Welded Steel Standpipe

The 1,500,000-gal. Horton standpipe shown above is an all-welded steel structure which we erected at Elk City, Okla. It is 60 ft. in diam. by 72 ft. high and has an umbrella roof.

Horton reservoirs of this type are widely used for storing large volumes of water because they are economical to construct and easy to maintain. Their welded joints are made water-tight and stay that way. Write our nearest office for information on standpipes or elevated water tanks.

CHICAGO BRIDGE & IRON COMPANY

BIRMINGHAM
PHILADELPHIA
SAN FRANCISCO

CHICAGO
NEW YORK
HOUSTON

TULSA
DETROIT
ATLANTA

BOSTON
SEATTLE
HAVANA

SALT LAKE CITY
CLEVELAND
LOS ANGELES

Rate Analysis:
Recording & Statistical Corp.
Recorders, Gas Density, CO₂, NH₃, SO₂, etc.:

Permutit Co.
Wallace & Tiernan Co., Inc.

Recording Instruments:
Builders-Providence, Inc.
Inflico, Inc.
R. W. Sparling
Wallace & Tiernan Co., Inc.

Reservoirs, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Sand Expansion Gages; see Gages

Sleeves; see Clamps

Sleeves and Valves, Tapping:
James B. Clow & Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Sludge Blanket Equipment:
Cochrane Corp.
Permutit Co.

Soda Ash:
Solvay Sales Div.

Sodium Hexametaphosphate:
Blockson Chemical Co.
Caigon, Inc.

Softeners:
Cochrane Corp.
Dearborn Chemical Co.
Dorr Co.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Inflico, Inc.
Permutit Co.
Roberts Filter Mfg. Co.
Walker Process Equipment, Inc.

Softening Chemicals and Compounds:
Calgon, Inc.
Inflico, Inc.
Permutit Co.
Tennessee Corp.

Standpipes, Steel:
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Steel Plate Construction:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Stops, Curb and Corporation:
Hays Mfg. Co.
James Jones Co.
A. P. Smith Mfg. Co.

Storage Tanks; see Tanks

Strainers, Suction:
M. Greenberg's Sons
R. D. Wood Co.

Surface Wash Equipment:
Permutit Co.
Stuart Corp.

Swimming Pool Sterilization:
Everson Mfg. Corp.
Omega Machine Co. (Div., Builders Iron Fdry.)

Proportioneers, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Tanks, Steel:
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Pittsburgh-Des Moines Steel Co.

Tapping Machines:
Hays Mfg. Co.
A. P. Smith Mfg. Co.

Taste and Odor Removal:
Cochrane Corp.
Industrial Chemical Sales Div.
Inflico, Inc.
Proportioneers, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Telemeters, Level, Pump Control, Rate of Flow, Gate Position, etc.:
Builders-Providence, Inc.

Turbidimetric Apparatus (For Turbidity and Sulfate Determinations):

Hellige, Inc.
Wallace & Tiernan Co., Inc.

Turbines, Steam:
DeLaval Steam Turbine Co.

Turbines, Water:
DeLaval Steam Turbine Co.

Valve Boxes:
Central Foundry Co.
James B. Clow & Sons
Ford Meter Box Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valve-Inserting Machines:
A. P. Smith Mfg. Co.

Valves, Altitude:
Golden-Anderson Valve Specialty Co.
Ross Valve Mfg. Co., Inc.

Valves, Butterfly, Check, Flap, Foot, Hose, Mud and Plug:
James B. Clow & Sons
M. Greenberg's Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
R. D. Wood Co.

Valves, Detector Check:
Hersey Mfg. Co.

Valves, Electrically Operated:
James B. Clow & Sons
Golden-Anderson Valve Specialty Co.

Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.

Valves, Float:
Golden-Anderson Valve Specialty Co.
Ross Valve Mfg. Co., Inc.

Valves, Gate:
Dresser Mfg. Div.
James Jones Co.

Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Hydraulically Operated:
James B. Clow & Sons
Golden-Anderson Valve Specialty Co.

Kennedy Valve Mfg. Co.
M & H Valve & Fittings Co.
Philadelphia Gear Works, Inc.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Large Diameter:
James B. Clow & Sons
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co.
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Valves, Regulating:
Golden-Anderson Valve Specialty Co.
Ross Valve Mfg. Co.

Valves, Swing Check:
James B. Clow & Sons
Golden-Anderson Valve Specialty Co.

M. Greenberg's Sons
M & H Valve & Fittings Co.
Rensselaer Valve Co.
A. P. Smith Mfg. Co.
R. D. Wood Co.

Waterproofing
Dearborn Chemical Co.
Inertol Co., Inc.

Water Softening Plants; see Softeners

Water Supply Contractors:
Layne & Bowler, Inc.

Water Testing Apparatus:
Hellige, Inc.
Wallace & Tiernan Co., Inc.

Water Treatment Plants:
American Well Works
Chain Belt Co.
Chicago Bridge & Iron Co.
Dearborn Chemical Co.
Dorr Co.

Everson Mfg. Corp.
Graver Water Conditioning Co.
Hungerford & Terry, Inc.
Inflico, Inc.

Pittsburgh-Des Moines Steel Co.
Roberts Filter Mfg. Co.
Stuart Corp.
Walker Process Equipment, Inc.
Wallace & Tiernan Co., Inc.
Welsbach Corp., Ozone Processes Div.

Well Acidizing:
Dowell Incorporated

Well Drilling Contractors:
Layne & Bowler, Inc.

Wrenches, Ratchet:
Dresser Mfg. Div.

Zeolite; see Ion Exchange Materials

A complete Buyers' Guide to all water works products and services offered by A.W.W.A. Associate Members appears in the 1950 Membership Directory.

HERE'S WHY THE DESIGN OF LOCK JOINT CONCRETE CYLINDER PIPE ASSURES SUPERIOR PERFORMANCE—PERMANENTLY

1. Steel cylinder provides a positive seal or membrane as well as part of the required total steel area. Each cylinder is hydrostatically tested to a unit stress of at least 22,000 psi.

2. Steel rod reinforcement in the form of a single or double cage (as required by job conditions) supplements the steel cylinder and the two together provide the total required cross-sectional steel area.

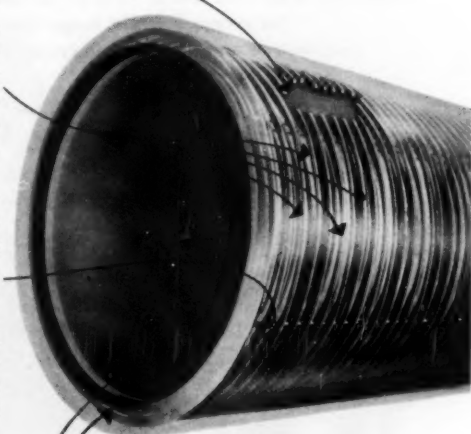
3. A thick wall of well-made concrete (poured and vibrated) encases the entire reinforcement assembly, producing a rigid pipe of great strength.

The three foregoing features combined, permit greater flexibility in designing a pipe for both high internal pressures and heavy external loads.

4. Smooth inside surface provides maximum sustained flow characteristics.

5. Lock Joint Rubber Gasket Joints afford ease of installation and assure positive, watertight closures.

The proper and economical combination of steel and concrete to meet varying design requirements offers important savings in the cost of pipe.



Manufactured in diameters of 36" to 144" and for operating heads of 100' and greater. This class of reinforced concrete pressure pipe conforms to tentative specifications 7B. I-T-1947 of the American Water Works Association. Complete information upon request.

American

PIPE AND CONSTRUCTION CO.

Concrete Pipe for Main Water Supply Lines, Storm and Sanitary Sewers, Subaqueous Pipe Lines

P. O. Box 3428, Terminal Annex,
Los Angeles 54, California

Main Offices and Plant—4635 Firestone Blvd., South Gate, Calif.

District Sales Offices and Plants — Oakland • San Diego • Portland, Ore.

Rockwell Disc Meters



**LOOK INTO THIS
SUPERIOR DESIGN!**

Your own eyes will tell you that Rockwell Arctic and Tropic disc meters are better designed, better built. Every tested and proved disc meter refinement is included in their construction. They are packed with performance for greater accuracy, longer life, lower repair costs. Get the facts now. Write for an eye-opening demonstration.



**ARCTIC TYPE
FOR COLD CLIMATES**

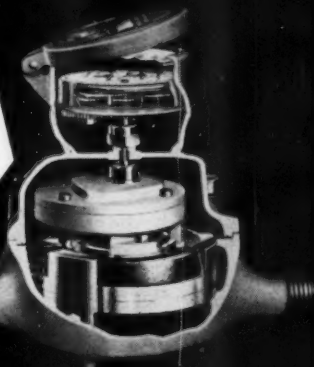
Size $\frac{1}{8}$, $\frac{3}{8}$, 1 in.

A bronze case meter with
breakable frost bottom

**TROPIC TYPE
FOR WARM CLIMATES**

Size $\frac{1}{8}$, $\frac{3}{8}$, 1 in.

All-bronze, split case
construction



Rockwell

MANUFACTURING COMPANY

PITTSBURGH 8, PA.

Atlanta • Boston • Chicago • Columbus • Houston • Kansas City
Los Angeles • New York • Pittsburgh • San Francisco • Seattle • Tulsa

"Hey, Joe! Did you ever see a \$100 bolt?"



JOE: "What d'ya mean, a hundred-dollar bolt?"

GUS: "Just what I said. We're raising Number 3 Gate just now and this anchor bolt let go."

JOE: "But we put that gate in less than two years ago, and . . ."

GUS: "Yeah, I know. But we used ordinary bolts and this one's already rusted through. It'll cost at least a hundred bucks to take that gate out, dig the old bolt out of the concrete and set a new one in."

JOE: "I guess it will. But from here out we don't make that mistake twice. From now on everything that goes in is Everdur."

Most sewage and waterworks engineers have discovered that the most economical way to lick the corrosion problem in their plants is to use Everdur®—ANACONDA's copper-silicon group of alloys. There are plants where equipment made of Everdur has been doing it for over 22 years.

If you don't already know about Everdur, let us tell you about its high strength, durability and how easy it is to fabricate it into lightweight, low-cost wrought assemblies. Just ask for the Everdur booklets. Let our Technical Department counsel you on any special problems or applications. Write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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Where corrosion resistance counts—use Everdur

ANACONDA

copper-silicon alloys

*Reg. U.S. Pat. Off.

LEADITE

Jointed for . . . Permanence with LEADITE

Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains **MUST BE GOOD**,—**MUST BE DEPENDABLE**,—and that is just why so many Engineers, Water Works Men and Contractors aim to **PLAY ABSOLUTELY SAFE**, by specifying and using **LEADITE**.

Time has proven that **LEADITE** not only makes a tight durable joint,—but that it improves with age.

*The pioneer self-caulking material for c. i. pipe.
Tested and used for over 40 years.
Saves at least 75%*

THE LEADITE COMPANY
Girard Trust Co. Bldg. Philadelphia, Pa.



No Caulking'

